SAE journal

JUNE 1958

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AIRCRAFT

Environmental Factors Affecting Bearings for Aircraft Motor Applications, H. B. JOHNSON. Paper No. 17A presented Jan. 1958, 5 p. High maximum operating temperature and large range of temperatures involved are noted as most critical environmental requirements from standpoint of successful bearing operation in high performance, supersonic aircraft motors; application of bearings at temperatures of -85 F to 450 F and -100 F to 600 F discussed.

Mechanical Factors Involved in Bearing Mounting, T. BARISH, R. J. ESCHBORN, C. M. ONG. Paper No. 17B presented Jan. 1958, 5 p. Specific aims for ball bearing developments for aircraft electrical accessories, with discussion of grease lubricated bearings for high temperature applications, and standardization and stocking of stabilized bearings; experience in application of ball bearings on aircraft electrical accessories.

Protective Atmospheres for High-Temperature Bearing Operation, C. H. BAILEY, S. S. SOREM, A. G. CATTANEO. Paper No. 24A presented Jan. 1958, 11 p. Reference made to new method which permitted ball and roller bearing operation at high temperatures without use of liquid lubricants or greases (see Engineering Index 1956 p. 114); report of Air Force sponsored research program now under way to further develop this method and determine range of conditions where it may be usefully applied; satisfactory results obtained with ferrous metal bearings.

Air Traffic Control — Some Problems & Some Solutions, H. S. CHANDLER. Paper No. S45 presented Jan. 1958 (Wichita Sec) 7 p. Four major problems in air traffic control are growth of operations, increasing congestion in airspace, increasing performance capability in aircraft and control system based on slow manual methods; 5-yr plan developed by CAA to meet these problems; principal items of plan are great expansion of navigation aids that provide guidance in network of routes, expansion of radar facilities, etc.

Economics of Jet Transports, J. D. DONALDSON. Paper No. S54 presented Jan. 1958 (San Diego Sec) 8 p. Comparison of block speeds of large long range and smaller short range airplane, and medium range jet transport which will become operational in 1960; computed direct costs as compared to actual costs are shown for two aircraft now operating; typical curve of cents per seat mile vs range indicates effect of low block speed in short range; indirect costs.

Techniques Involved in Aircraft Accident Investigation, M. V. CLARKE. Paper No. S57 presented Feb. 1958 (Washington Sec) 14 p. Organization of Civil Aeronautics Board's Bureau of Safety which is charged with accident investigation and consists of four divisions; how different units function in investigation; general approach used in all investigations; different procedures and techniques employed by various technical groups in accomplishment of their work.

Performance Limitations and Civil Air Regulations, O. BAKKE. Paper No. S63 presented Feb. 1958 (Metropolitan Sec) 8 p. History of efforts to regulate civil aviation in United States since 1926; first airplane certificated under transport category airworthiness requirements was Boeing S-307 which received its certificate in 1940; operating limitations introduced by Civil Aeronautics Board; regulation of irregular air carrier industry.

Collision Avoidance System for Aircraft, Y. J. LIU, J. O. CAMPBELL. Paper No. 43B presented Apr. 1958, 11 p. Functional and physical requirements for anticollision device are es-

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tablished with reference to commercial carrier midair collision problem; collision avoidance system (CAS) performs coding and transmitting, receiving and decoding, direction finding, computing, warning and commanding; possible applications.

FUELS & LUBRICANTS

Future of Aircraft Fuels, R. J. HEASTON. Paper No. 41A presented Apr. 1958, 7 p. Need for accelerated development of new fuels suitable for many operational air breathing weapon systems, embracing all types of fuels from modified hydrocarbons to exotic substances; four main criteria are thermal stability, specific gravity, heating value, and reactivity; high energy boron fuels (HEF), hydrocarbon and carbon-boron-hydrogen fuels and process approaches involved.

New Fuels for Piston-Engine Aircraft, F. P. GLAZIER. Paper No. S56 presented Jan. 1958 (Metropolitan Sec) 12 p. Effects of higher performance number fuels upon present day modified piston engines and aircraft; recent development by Ethyl Corp of anti-detonant material known as AK-33-X and identified as methyl-cyclepentadienyl - manganese - tricarbonyl; potential of AX-33-X for improving performance of aviation gasoline in reciprocating aircraft engines indicates that AK-33-X may be used in airline operation within foreseeable future.

Use and Effects of Radiation and Radio Active Isotopes in Fuel Studies, R. McBRIAN. Paper No 16A presented Jan. 1958, 18 p. Method of evaluation employed by Denver Rio Grande Rail-Road Co. depends upon use of electron microscope; use of radiation is applied in light of atomic knowledge to overall problem of fuels; examples demonstrate how radioactive isotopes are used to secure economically operating conditions in diesel and kerosene type fuels; technique used in coal radiation with coal alone and coal and oil mixtures; future experimentation.

Characteristics of Silicone Bearing Lubricants, W. H. RAGBORG. Paper No. 18C presented Jan. 1958, 8 p. Requirements for antifriction bearing lubricants with long life and operability over ever broadening temperature range met by silicone greases; properties of two types of silicone fluid lithium soap bearing greases; improved high temperature grease thickeners to combine with more stable silicone fluids for producing new antifriction bearing lubricants; performance of arylurea silicone greases in aircraft equipment bearings.

Selection and Specification of Antifriction Bearing Greases for High Speeds and High Temperature, R. S. BARNETT. Paper No. 18A presented Jan. 1958, 10 p. List of eight functional tests for antifriction bearing greases available at Texaco Research Center; difficulties encountered in functional testing as compared to plant trials; development of high temperature high speed lubricating greases and of high rotative speed test technique for grease lubricated bearings.

GROUND VEHICLES

Buick Flight Pitch Dynaflow, F. McFARLAND, C. S. CHAPMAN. Paper No. 29A presented Mar. 1958, 15 p. Triple turbine transmission with stator control allows continuous variation of stator blade pitch and contains 5-element torque converter in combination with two planetary gearsets; elements consist of engine driven pump member, three turbines and stator; aluminum used extensively to reduce weight and facilitate machining; development problems.

Automatic Transmissions and Torque Converters, F. McFARLAND. Paper No. S51 presented Jan. 1958 (Metropolitan Sec) 11 p. History of automatic transmissions and torque converters; early designs; development of step gear automatic transmission with fluid couplings; torque converter transmission combined with gearing.

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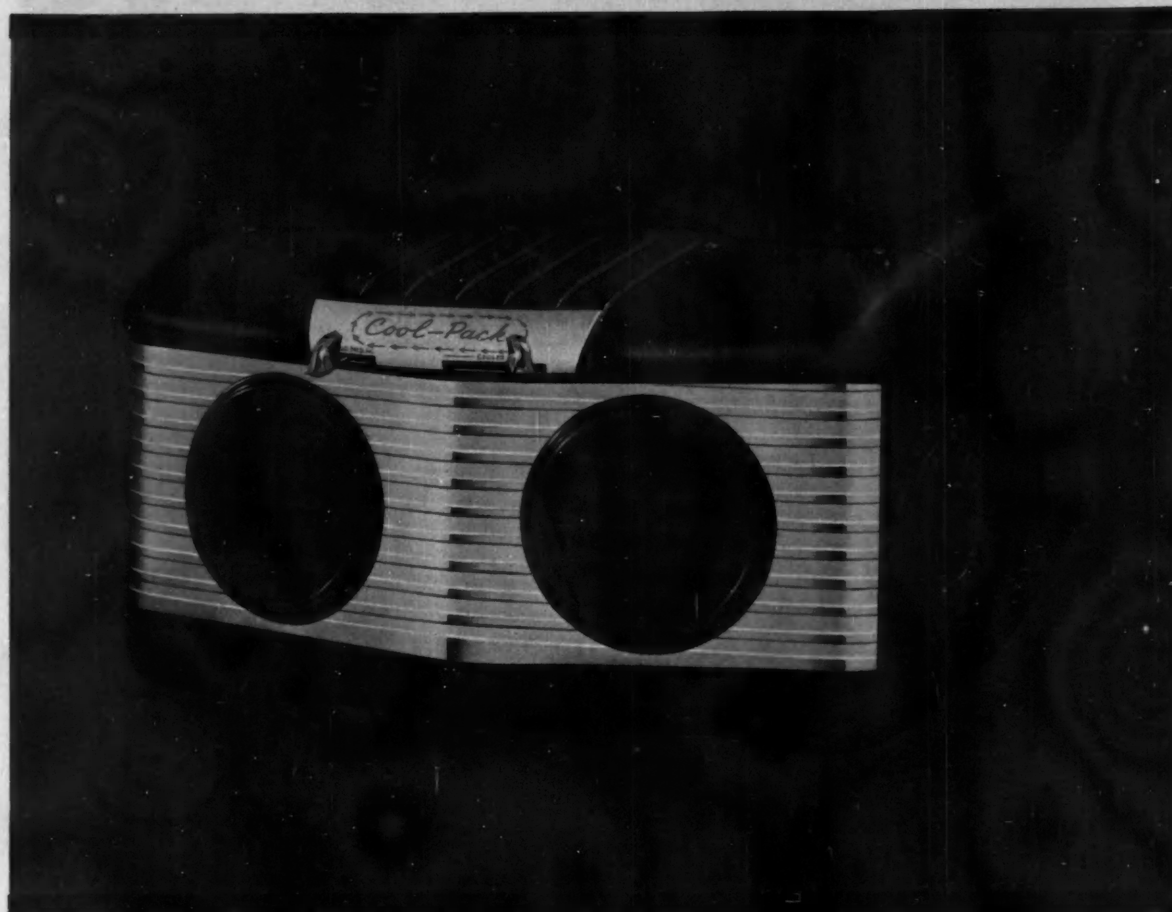
COOL AIR BY THE CARLOAD!



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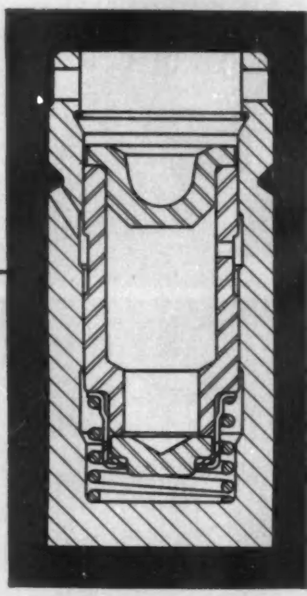

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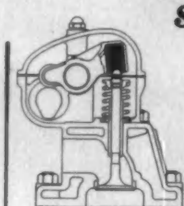

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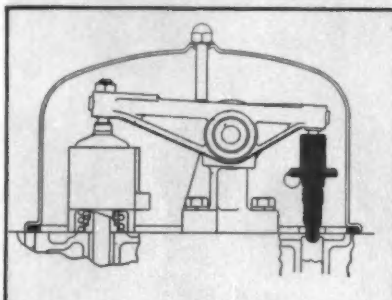

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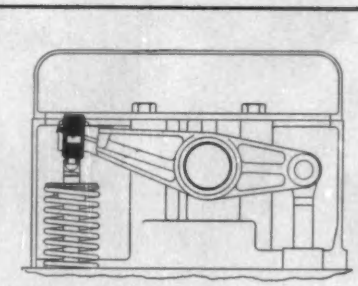

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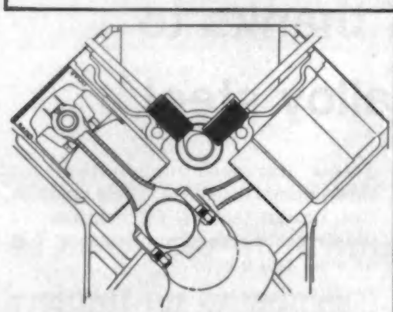

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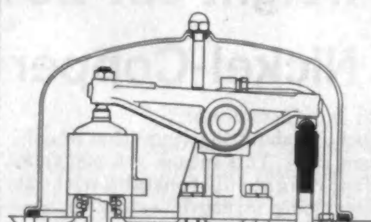

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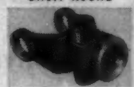

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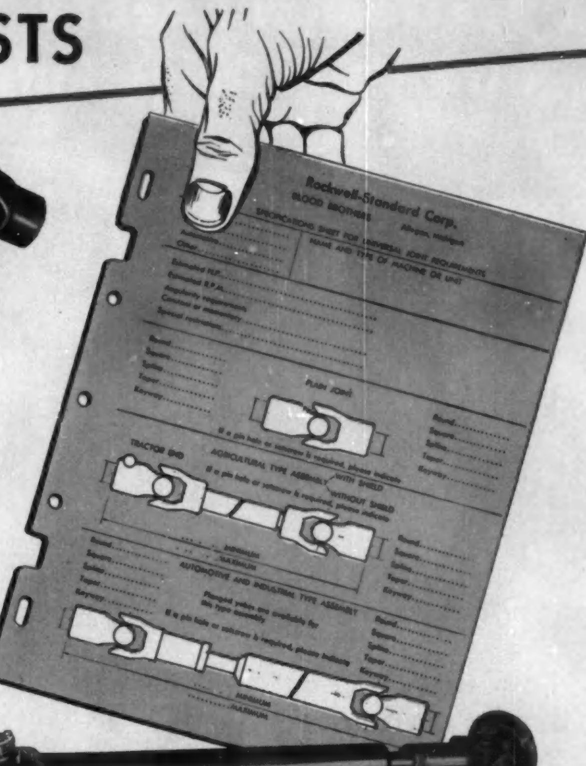

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For example, one maker of eight types of machines cuts costs by using only three sizes of joints. This means smaller inventories, fewer parts to catalog and stock, and volume prices.

TWO—Save time at the start of new projects by sending us a "Spec Sheet" with your data. Our engineers will submit drawings and recommendations that may forestall problems later.

Blood Brothers builds more standard types and sizes of universal joints than any other manufacturer—and will gladly work with you to help cut costs.

Just write or call—and request your supply of handy blank "Spec Sheets" for use now or later.

ROCKWELL-STANDARD CORPORATION

(Formerly Rockwell Spring and Axle Company)

Blood Brothers Universal Joints

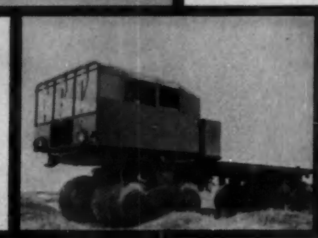
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Many leading manufacturers of quality, wheeled equipment specify

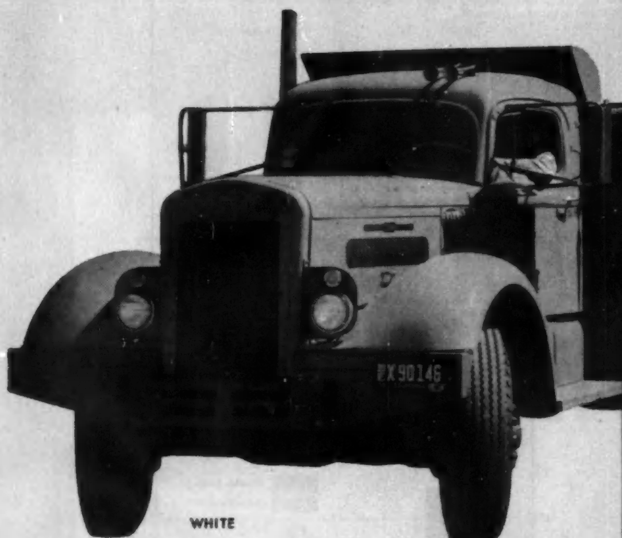
GARRISON POWER STEERING

LIMA



FWD TERRA-CRUZER

DIAMOND T



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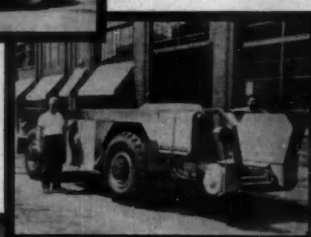

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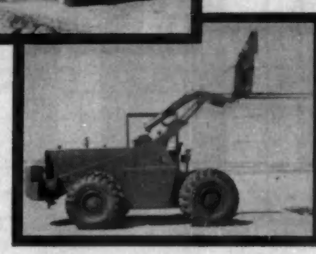
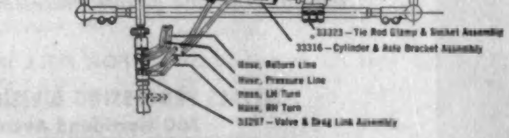


CLARK

Models now available for all medium and heavy trucks, truck cranes, motor graders, and wheeled, material handling and off-the-road equipment.

Leading manufacturers of such wheeled equipment as shown above offer Garrison Power Steering as standard or optional equipment installed at the factory, or in kit form for field installation.

The effortless steering, increased equipment life, greater safety and servicing ease, possible with Garrison Power Steering, have made it the favorite of both operator and owner. Investigate its advantages today.



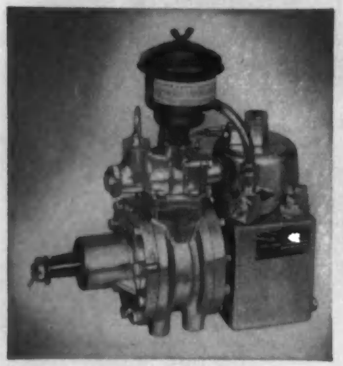
Power cylinder and control valve installation on a White Truck, WC Model.

GARRISON Manufacturing Co. Inc.

4609 East Sheila Street, Los Angeles 22, California

For the most reliable vehicle air brake systems—

Wagner ROTARY AIR COMPRESSORS



provide ample air...require less maintenance

It is sound judgement to equip the air brake systems of heavy duty vehicles with Wagner Rotary Air Compressors, because Wagner Compressors have the following special features:

HIGH VOLUMETRIC EFFICIENCY Rotary compression forces all air from the compression chambers. Pressure recovery is rapid at all compressor speeds.

LOW TEMPERATURE AIR DELIVERY Oil separation and cooling before air is discharged reduces temperatures and prevents carbon formation. Fire hazard is reduced. Flexible connection may be used in discharge line.

UNIFORM TORQUE LOAD Thousands of small overlapping air compression impulses per minute maintain a more uniform load with moderated stresses and assure smooth, quiet operation with long belt life.

LOW FRICTION LOSS All rotating parts are turned by the rotor shaft, suspended on two bearing surfaces.

HIGH R.P.M. Compressor can be operated at high R.P.M. High reduction drives are unnecessary.

The Wagner Rotary Air Compressor pumps compressed air into the air reservoir, providing the pressure required for the operation of brakes and other air powered devices. The compressor runs continuously while the engine is operating. Pumping is regulated by a control valve which starts or stops air compression by "loading" or "unloading" the compressor proper. This action establishes an intermittent pumping cycle which keeps reservoir pressure within the desired range.

You have a choice. These rotary compressors are available in either 9 C.F.M. capacity, air or water-cooled, or 12 C.F.M. capacity, water-cooled, and are *standard* with every Wagner Air Brake System.

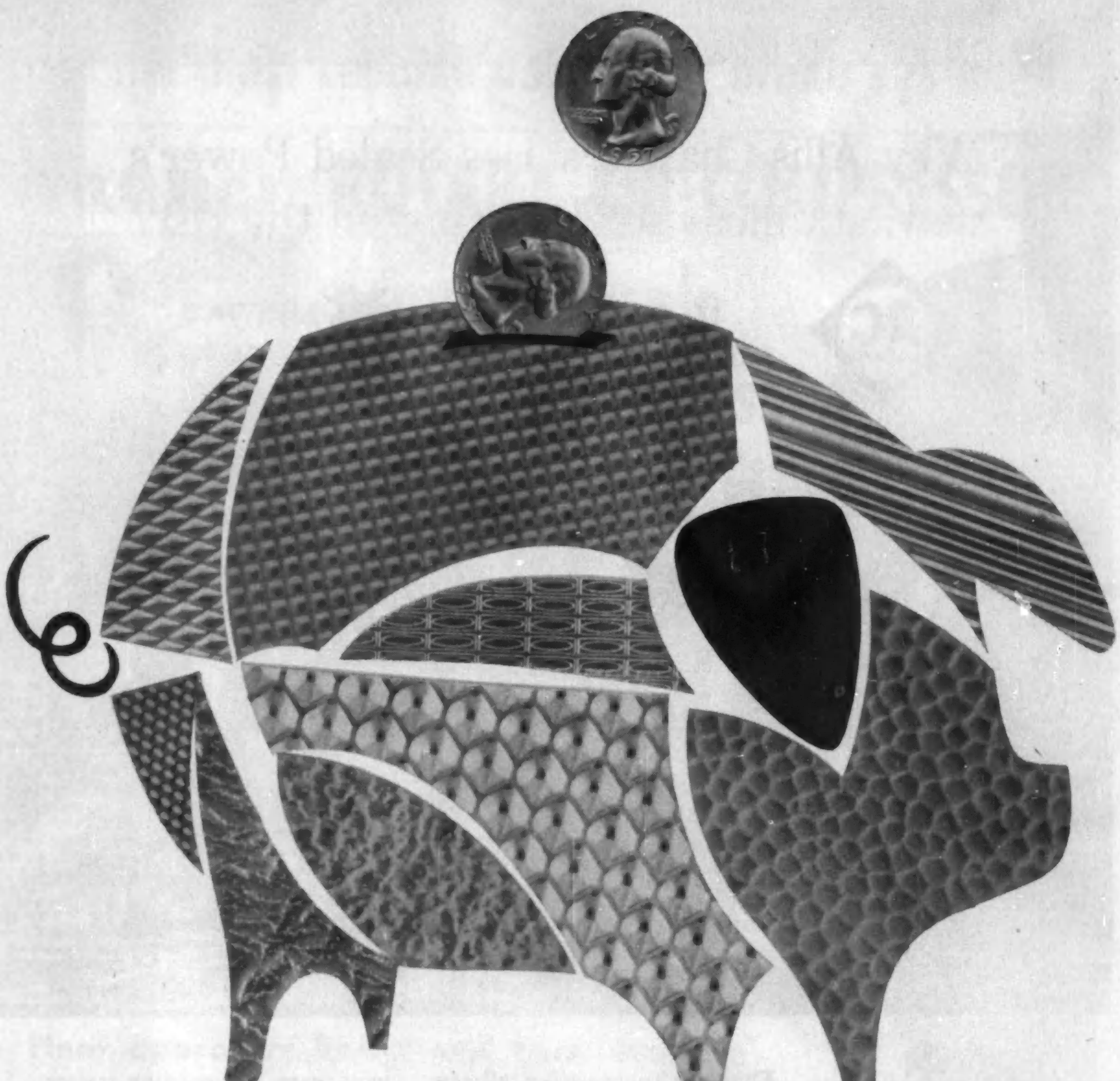
For details on these compressors, Wagner Air Brake Systems and Equipment for trucks, tractors, trailers, buses and off-the-road equipment ... request a copy of Catalog KU201B.

Fleet operators know and trust Wagner

Wagner Electric Corporation
6378 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.
(Branches in principal cities in U. S. and in Canada)

ask for Catalog KU201B

WK58-2A



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Count on Firestone's complete new facilities for low-cost, mass produced parts and trim for automotive products and home appliances.

Brightening a product or part with aluminum trim? Trying a new texture or tint? Whatever you want — from small panels to part sizes up to seven feet long — you'll get it first, and you'll get it *Fashionized* at Firestone. For Firestone teams almost 50 years of experience in metal fabrication with the most completely automated anodizing facility in the industry. Fashionized Aluminum, delivered at competitive schedules and costs, lets you make widest use of color trim. Your inquiries and inspection of our capabilities, capacities and costs are cordially invited. Write, phone or wire today.

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For The Sake of Argument

Been There Before?

By Norman G. Shidle

SOME FOLKS help the boss to solve *his* problems. . . . And they often find this activity rewarding despite lack of appreciation.

Even when he takes all credit, the boss can't steal away the experience acquired in handling higher echelon posers. He can't obscure the clearer view obtained of your own work in relation to overall department or company objectives. He can't impinge on the satisfaction of having reached for a challenge and met it well.

Only the shortsighted will complain: "I was a sucker to do his work for him, when he grabs all the glory." (The glory-grabbing boss, of course, is the really shortsighted one. Trying to look important, he decreases his stature by belittling that of his subordinates.)

The big reward for helping to solve the boss' problems is the chance it usually brings to work in *more* boss-type areas . . . the chance to experiment, unburdened by responsibility for immediately perfect results. On such trial spins, there is everything to gain, little to lose.

Besides, most bosses are trying to unearth talents to supplement their own, not to bury them. Many see their own future brightening as *their* bosses recognize growing stature in the men their supervision develops.

They want subordinates to get experience with boss-type actions. Only such men, they realize, can climb aboard any supervisory job with the surefootedness known to those who have been there before.

BENDIX SELF-ADJUSTING BRAKES ADD TO THE SAFETY AND ECONOMY OF THESE TWO GREAT CARS

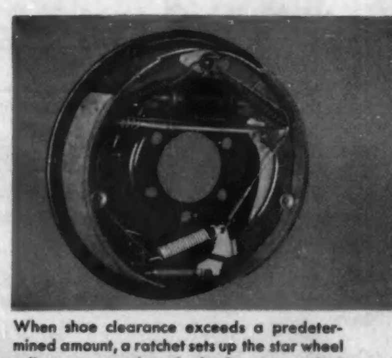
Mercury and Edsel for 1958 feature Bendix' latest development—brakes that adjust themselves!

The new Bendix* Self-Adjusting Brakes not only save the bother and expense of periodic brake adjustments but are safer, too. Stopping power is maintained at maximum because all four shoes are always correctly adjusted. And the driver is assured of effective brake applications because there is always maximum clearance between pedal and floor.

Reasons such as these make Bendix Self-Adjusting Brakes a real sales feature for any car. We predict you will hear more about them in the years ahead.

For over thirty years Bendix Products Division has demonstrated its ability not only to meet, but to anticipate the needs of the automotive industry. From four-wheel brakes to power braking and power steering, Bendix has pioneered and developed many of the industry's most notable advancements.

*TRADE MARK



When shoe clearance exceeds a predetermined amount, a ratchet sets up the star wheel adjuster one notch as the brakes are applied while the car is in reverse. This automatically compensates for lining wear, adjusting the shoes to exactly the right fit within the drum.

Bendix PRODUCTS DIVISION South Bend, IND.

Bendix AVIATION CORPORATION

chips

from SAE meetings, members, and committees

MISSILE HYDRAULIC SERVO VALVES have the same problem as a mouse leading an elephant. Weak electrical control signals must be multiplied up to 20,000 times by the hydraulic servo valves. At the same time this power must be applied rapidly and accurately to guide a missile to a maneuvering target.

•

THERMOGRAPHIC PHOSPHORS are particularly effective to show flows in the bonding of laminates or of sheets to substructures. These inorganic, crystalline materials of the zinc sulfide type emit visible light under ultraviolet excitation. Brightness of the light varies with change of temperature.

For a zinc-cadmium sulfide, silver-actuated and containing a trace of nickel, the brightness variation amounts to 24% per deg (C) change in temperature. Thus, this material can be used:

- To show heat-flow patterns and variable electrical conductivity of thin surface layers.
- To detect flaws that are near the surface of a material.

•

A "SQUAWK BOX" system now ties all Trans World Airlines' maintenance and overhaul bases to a core of maintenance experts at TWA's Kansas City base. System was planned with the complicated new turbine aircraft in mind. Every day all the outlying maintenance outfits will get a chance to bring their maintenance problems to the experts, who will control the jobs without leaving Kansas City.

Because the huge, expensive new transports must be kept busy earning money every possible hour and because repair of their components is so exacting, most airlines plan to remove defective units, replace them with spares, have specialists do the repairing at a main base. Most mechanics won't get their hands inside units at all. Their work will, therefore, be so much cleaner that they may achieve a new status among workers.

•

PROJECT ZIP FUELS will have 25,000–27,000 Btu per lb heating values or 40% higher than JP-4 fuel. A boron-hydrogen-carbon compound may fire turbojets, afterburners, and ramjets if pilot plant operation produces a fuel with good handling and deposit characteristics.

•

50% INCREASE in members seeking new jobs through the SAE Placement Service between March 1 and May 1 is a not-unexpected sign of the times . . . but the average for the last six months is only 40% above a year ago. It's also good that a leveling off now seems to be taking place and new job openings continue to come in. Most recently, they have been coming in faster . . . with quite a number in the aeronautic field.

FOR SPACE TRAVEL, Mach numbers (which relate velocities to speed of sound) don't make much sense . . . even though they are convenient enough for expressing velocities of manned aircraft and some missiles.

Solution suggested at SAE's recent National Aeronautic Meeting is to use the ratio of the velocity in question to the orbital velocity at the altitude in question.

•

HOW SUCCESSFUL are the Russians in developing light-weight equipment for producing electrical current directly from nuclear sources? A recent SAE paper quotes an article on nuclear propulsion for aircraft in "Soviet Aviation" for July 29, 1957 as saying: "Presently existing radioactive sources of current are still very ineffective. They can be used only for supplying airplane accessories."

Cells utilizing various forms of nuclear energy are under development in the United States. But in the present state of development, the paper notes, they are believed to have too high a fixed weight per unit output for airborne use.

•

PYROCERAMS, a new family of fine-grained crystalline materials, are made by a process of controlled crystallization from special compositions containing nucleating agents.

These glass-ceramics are like

chips

from SAE meetings, members, and committees

glasses in their ability to resist chemical attack and are lighter and harder than most metals. They are heat and electrical insulators, have a higher Young's modulus than glass, strengths higher than glasses and most ceramics, and are classed as brittle materials.

Applications envisioned include such products as air compressor blades, abrasive binders, radar antenna housings, brake shoes, structural parts for hypersonic aircraft, piston heads, high temperature bearings, and heat exchangers where severe abrasive conditions exist.

•

CEMENT rather than bolts, nuts, and welds may be used to assemble the car of the future, some engineers say. Metal-to-metal bonding, such as is already employed by airplane makers, would make it possible to design thinner roof rails and reduce frame structure height. This would aid manufacturers' efforts to reduce overall car height.

•

AN UNCOMFORTABLE RIDE in a bus, car, or truck can be a harrowing experience. Chances are that the fore-and-aft "jerking" motion was the cause — rather than the up-and-down bumps. That is because you are two or three times more sensitive to fore-and-aft changes in acceleration. The neck acts as a hinge in this direction and lets your head fly back and forth.

THE DAY is coming when air transport won't be able to afford domestic operators.... All operators will have to be international in scope to use equipment properly. So predicts one air transport engineer. Tokyo-Fairbanks-Europe, he says, will be like Chicago - Omaha - Denver today. Polar operation will be "main line" after some real understanding is reached with Russia....

•

FREQUENT CONVERSATION STARTER among members of SAE Committee S-12: "How dou you like your new woofer and tweeter?" To the unititiated, these experts on aircraft shock and vibration problems will explain that the terms refer to base and tenor speakers for hi-fi systems, which are the hobby of practically all the members of the Committee.

•

RUSSIAN SATELLITES are broadcasting on frequencies usually kept clear for safety-of-life-and-property-in-the-air communications ... which is a sample of the sort of problem that may bring space penetration rights to UN General Assembly debate one of these days.

UNGA's next session is already scheduled to take up certain legal problems of space occupancy, says its president Sir Leslie Monro ... Discussion the other day at an International Society of Aviation Writers forum indicated a consensus that space law certainly shouldn't be just extrapolation of maritime law . . . and that the "effective control" which has been proposed as the basis of sovereignty isn't right . . . because might doesn't make right.

One suggested "for-now" solution: Set up under the UN an organization like that for the International Geophysical Year. Have that organization work out whatever regulations are really needed at this stage of technology. Let its objective be to keep the heavens free for scientific research ... to foster positive collaboration on an international level . . . not just to impose negative restraints.

•

MADE FROM FORMALDEHYDE is a new plastic which is called Delrin acetal resin. Difference from previous resins of formaldehyde is that it has very long chains and excellent thermal stability.

•

THREE-QUARTERS of the displacement of one cylinder of a 1958 Plymouth V-8 engine — or 500 cc — is considered the maximum displacement for those amazing minicars, like the Zundapp Janus (250 cc), the Goggomobil (293 cc), the BMW Isetta (298 cc), on up to the Fiat 500 (479 cc). Yet such cars are capable of carrying four adult passengers — except the Isetta, which carries two — at top speeds of 50–65 mph.

1958 March Meeting Plans began in June, 1957

How An SAE Paper Is Born

by

Joseph M. Callahan,

Automotive News

(Reprinted from Automotive News)

"MR. CHAIRMAN, SAE members, and guests."

With this introduction many a young automobile engineer or distinguished veteran engineer reaches an important milestone in his career. He has been selected as an expert on some subject and is addressing 200–800 other engineers at a Society of Automotive Engineers meeting.

Although the speech will be only 30–90 min long, behind it will be some nine months of activity and thought by many of the top-flight engineers in the business.

On occasion, as much as $5000 has been spent by a company on displays, films, and slides for an SAE presentation.

An idea of what lies behind an SAE paper might be gleaned by examining a paper such as, "The Buick Flight-Pitch Dynaflow," which was delivered at the recent SAE National Passenger-Car, Body, and Materials Meeting in Detroit by Forest McFarland and Charles S. Chapman, both of Buick.

This paper was designed to help fulfill the second of the SAE meetings' objectives — the interchange of basic new product development information. The other and more important objective is the interchange of basic automotive engineering principles.

In the circulation of product information, the SAE officers are constantly on the watch for commercial pitches, operating much like an editor in separating the worth while from the worthless.

However, just because a product is on the market doesn't necessarily mean that it doesn't embody new, worth-while engineering principles. On the contrary, this sometimes indicates that it has successfully passed the final test of engineering — marketability.

The Buick paper had its beginning last June when the committee of the SAE Passenger-Car Activity (one of the organization's 12 activities) met to decide how it would fill its quota of four of the nine discussions at the meeting nine months hence.

The Passenger-Car Activity, the largest SAE activity with about 4500 of the organization's 23,000 professional members, is guided by a committee of 33 of the top engineers in this field.

Pretz Heads 33-Man Unit

Phil H. Pretz, Ford Motor Co.'s executive engineer for vehicle testing, is chairman of this activity. Other committee members are J. S. Wintringham, Ethyl Corp.; J. H. Booth, Thompson Products; Paul C. Ackerman, Chrysler Corp. vice-president and director of engineering; John B. Beltz, Oldsmobile assistant chief engineer; H. M. Bevans, Chrysler Corp. engineer in charge of vehicle testing.

S. R. Billingsley, Stratoflex; M. G. Brush, Firestone Tire & Rubber Co.; C. C. Dybvig, general sales manager of Dana Corp.; W. H. Graves, professor of automotive engineering, University of Michigan; L. J. Halpenny, General Dynamics Corp.; H. J. Hannigan, National Carbon Co.; Eugene J. Hardig, Studebaker-Packard chief engineer.

George J. Huebner, Jr., Chrysler Corp. executive engineer for research; Ralph H. Isbrandt, American Motors director of automotive engineering and research; W. S. James, of William S. James & Associates; H. R. Johnson, Jr., Studebaker-Packard; R. F. Kohr, Ford Motor Co., director of vehicles testing; A. G. Loofbourrow, Chrysler Corp. executive engineer, product development and planning.

H. C. MacDonald, chief engineer of Mercury-Edsel-Lincoln division; H. A. Matthias, director of the Ford car and truck engineering office; L. H. Nagler, American Motors administrative engineer; V. D. Polhemus, in charge of GM's structure and suspension development; C. A. Rasmussen, Cadillac assistant chief engineer.

Victor G. Raviolo, special assistant to the vice-president of engineering and research, Ford Motor Co.; M. M. Roensch, a Chevrolet assistant chief engineer; Robert Schilling, Chevrolet director of research; T. H. Thomas, Bendix Products; R. J. Williams, American Metal Products; E. L. Windeler, Pontiac; G. R. Wynne, superintendent of Los Angeles police transportation, and V. C. Young, Eaton Mfg. Co.

When these committee members were invited to the preliminary meeting they were requested to furnish ideas about current (and sometimes future) problems and solutions in the industry. In addition to the ideas turned up in this fashion, there was also a carryover list of some 50 ideas on such subjects as bodies, lighting, safety, and suspension.

All these ideas were turned over to a seven-man steering committee, which narrowed the areas of interest to six or eight subjects.

The activity chairman then presented these subjects to the full committee, giving the pros and cons of each subject. After a full discussion in which the objections of any member were heard, the topics were voted on individually by the full committee.

Sometimes the SAE receives unsolicited papers on some subject. These are studied by a Paper Review Committee which may recommend it to the full committee for consideration like any other subject.

Selecting the Speaker

After a subject has been selected, the activity chairman and the members look for someone particularly well versed on the subject and willing to discuss it.

At last June's meeting the membership voted for a paper on a new Buick transmission which reportedly was to be introduced on the 1958 Buick.

Explained one engineer, "It gradually gets 'noised' about the industry when a company is coming out with a new product."

When the committee began looking for someone to speak on the new Dynaflow transmission, it found a somewhat unusual situation in that a member of its committee, McFarland, was probably the most qualified man to discuss the subject.

McFarland, an assistant chief en-

gineer at Buick, has developed a substantial reputation as a transmission engineer in the last 20 years. Before going to Buick, he was the chief developer of Packard's Ultramatic transmission and now holds most of the patents on it.

At a meeting last September McFarland was requested to write the paper. About that time it was agreed that Chapman, who was in direct charge of the transmission project, should co-author the paper with McFarland.

McFarland said, "We then checked with management to see if it would OK the paper. We got this OK within a day or two, and we immediately began thinking about it."

This gave McFarland and Chapman six months before the paper was to be delivered and three months before it had to be submitted to the SAE in New York. However, the SAE is trying to shrink this lead time so the papers will be more current.

After the activity committee approved the suggested paper on the Buick transmission, McFarland and Chapman received written notification from New York in which the deadline, suggestions for the paper and other requirements were set forth.

Authors are told that the SAE will provide the room and projectors, but that all slides, film, and displays must be provided at their expense.

Write, Study, and Rewrite

Six months before the national meeting was held, the program was all set and the authors and subjects were selected. The SAE always gets written agreements from the authors that they will deliver the papers at the appointed times.

Then, a chairman and a secretary are selected for the session. The chairman must be well qualified in the fields to be discussed, and also have a neutral, balanced point of view. Dave Sicklesfield, one of the principal developers of Borg-Warner's transmission, was selected for this meeting.

The session chairman then gathers the speakers together to eliminate any duplication by assigning each speaker to a certain area, to work out the proper order of the papers, and to make the program interesting and strong.

In these and other details, each SAE activity has it own method of operating.

McFarland continued, "Chapman wrote most of the paper. I edited it. It was written entirely out of the office. I usually write a rough draft, then study and rewrite it several times. Often you have others in your organization read the paper; then you rewrite it and read it again.

"We then went to work with the Buick photo department. We had prepared 21 drawings. Two glossy prints of each of these had to be sent with copies of the eight-page paper to the SAE review committee. Our deadline was in December, but we were a couple of weeks late."

An important compensation to the speaker is that the SAE will preprint several hundred copies of the complete paper, depending on the subject and the interest created.

Six weeks before the national meeting all SAE members and many members of the press are given a list of the papers to be offered, permitting them to order any they desire.

Members can order these papers for 50¢ each. The papers are made available before the meeting and also are sold at the meeting.

Discussion Follows Reading

"Sometimes a company will want a little fancier printing job and it will preprint an employee's paper itself," he continued. "On occasion, auto makers want to distribute copies of a paper to their dealers or to others. One company printed 8000 copies of a paper.

"The important thing is that if a paper is reprinted, it guarantees a much larger audience."

It's the job of the session chairman to make the meeting interesting and to limit it to two to three hours. Consequently, the oral paper will differ from the written paper in that it usually will be condensed to make it more interesting and to fit it into the prescribed time.

Very often the most interesting part of a session is the discussion after the papers have been delivered. The discussion consists of prepared and spontaneous statements and questions by members of the audience about the paper's subject.

Frequently, a chairman will line up several "discussers" and mail them copies of the paper two weeks before the meeting. Discussers are asked to give their name and company's name and to speak from the rostrum.

After an introduction by Chairman Sicklesfield, McFarland spoke briefly and generally about the Buick transmission. Then, Chapman delivered the paper.

Following this, there were several prepared and spontaneous replies to questions from representatives of GM's Detroit Transmission Division, Chrysler Corp. and Borg-Warner. Some of the remarks were complimentary, some were critical, and some were inquisitive.

Recording Discussion

It is the secretary's duty to record as much of the discussion as possible for inclusion with the paper if it is published in the future.

Sometime after the meeting, a Readers Committee of the SAE Publication Committee votes on each paper as to whether it shall be published as written in SAE Transactions, an annual publication of the Society. . . . The Committee also stands ready to advise SAE Journal editors on the handling of material in SAE Journal, the Society's monthly technical magazine.

Articles or digests based on every paper presented before SAE appear in SAE Journal.

Asked about the likelihood of a company's competitive secrets leaking into an SAE paper, a spokesman said, "We're interested in basic principles and in current products, not company secrets. Of course, sometimes an individual or a company won't talk about a subject because they're committed too far in it. To talk would reveal their program."

One SAE official concluded, "If you had to buy the talent that works on these programs or attends these meetings, it would take an awful lot of money."

COAUTHORS Forest McFarland (left), Buick assistant chief engineer, and Charles S. Chapman, Buick project engineer, study an early draft of paper they co-authored for the Society of Automotive Engineers 1958 National Passenger-Car, Body and Materials Meeting.

Computer Simplifies Purchasing Decisions

Based on paper by

Charles S. Knox
Caterpillar Tractor Co.

AN ELECTRONIC computer helps Caterpillar Tractor Co. to determine what steel sizes are most economical to purchase for a given piece part.

At Caterpillar, steel is purchased for piece parts in specific steel sizes. For example, a 10 in. by 12 in. piece part may be placed, more or less arbitrarily, on a code size of steel which is 48 in. wide by 120 in. long. Other parts with different dimensions may also be placed on the same steel code size.

If the sheet of steel requires trimming before the piece parts can be sheared to size, an allowance must be added to the basic steel size for this trim. At times, the piece part must be placed on a steel size which allows the grain flow of the steel to run in a desired direction.

When the dimensions for a steel size have been determined, it becomes a standard "code size" of steel, kept in the steel-size register, and ordered periodically to meet the requirements of the piece parts which are on it.

When a new drawing is released, certain basic restrictions appear on the blueprint of the part, forcing a new code size of steel to be designated or placing the piece part onto a steel size previously kept in the register. These restrictions are:

1. **Specification** — The chemical content, mechanical properties, and physical conditions are placed together into one description and called a specification.
2. **Commodity Code Number** — The code number describes the type of steel which must be used, the surface treatment required, and the edge condition of the steel.
3. **Thickness** — Two or more steel size designations are needed for piece parts with the same commodity code and specification when the thicknesses are different.

When these basic restrictions have been defined, a group of piece parts falls into such a category that all can be cut, burned, or sheared from the same piece of steel.

The final code sizes of steel and the amount to purchase are determined by considering the following variables:

1. Width extras.
2. Length extras.
3. Piece part shearing cost including trimming requirements.
4. Storage cost.
5. Carrying charges.
6. Piece part requirements.
7. Mill (vendor) restrictions.
8. Company handling limitations.

The graph of Fig. 1 shows the width extra cost for steel plate charged in excess of the base price of the steel. Note that as the width of the steel purchased increases, the cost per hundred pounds of steel decreases until a width of approximately 80 in. occurs. Then, as the steel width increases further, the cost once more increases. On the basis of this curve alone, it would seem that the least expensive steel to buy is approximately an 80 in. width.

Fig. 2 shows a graph of the length extra charge for steel plate. Here the cost per hundred pounds decreases as the length of steel purchased is increased. From Figs. 1 and 2, apparently the best steel to buy would be approximately 80 in. wide by 240 in. long.

Combining the width, length, and cost variables results in a surface similar to that shown in Fig. 3. While these surfaces vary cost-wise with the thickness of steel plate purchased, they form a family of similar surfaces for all plate and vary in nature and application only slightly for bar, sheet, or strip.

Once the optimum steel size is determined, the cost of shearing various piece parts out of a particular code size of steel becomes a factor, and choosing the right code size for a piece part to minimize shearing cost is of importance. Fig. 4 shows a graph of the shearing cost for a particular piece part based on variable widths and lengths of the steel upon which it is placed. Note that as the length of the steel increases, the shearing cost per piece part increases,

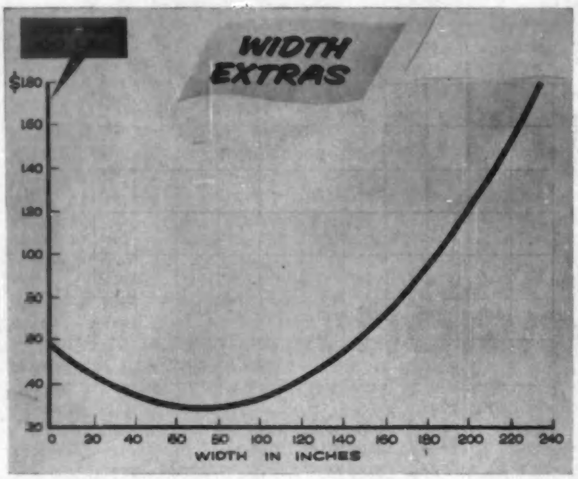


Fig. 1 — Width extra cost for steel plate charged in excess of the base price of the steel.

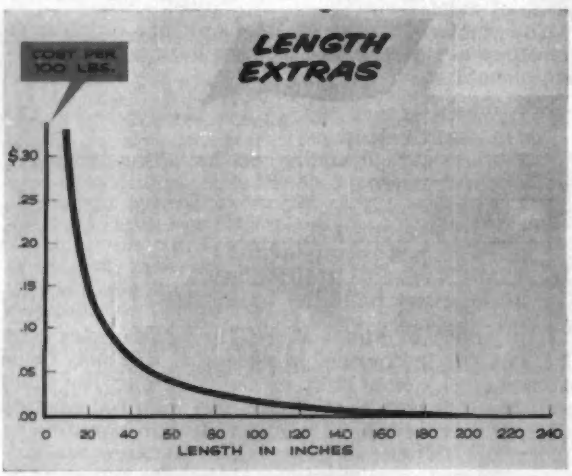


Fig. 2 — Length extra charge for steel plate.

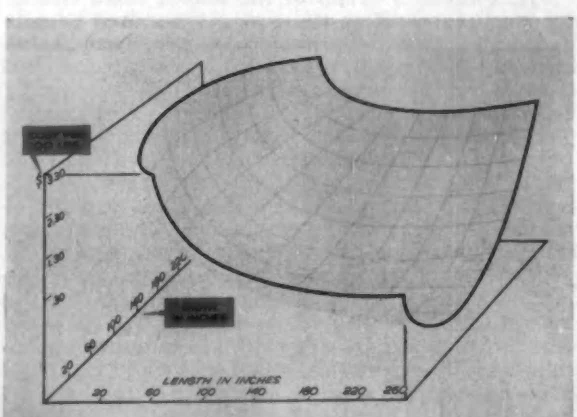


Fig. 3 — Width and length extras combined to form three-dimensional surface.

and that the width of the steel is particularly important because the cost of shearing rises rapidly as the width of the code size decreases.

To determine the most economical combination of length extras, width extras, and shearing cost would appear to require a master formula. Such an approach, however, would require procuring a different code size of steel for each part which would, of course, be highly impractical.

Natural limiting factors do exist, however, which mathematically reduce the number of steel code sizes necessary to a practical quantity. These limiting factors are carrying charges and, in particular, storage cost.

Fig. 5 shows the storage cost for a piece part for varying widths and lengths of steel where the requirements for the part are 5000 units yearly. Note that storage cost has a major effect on the overall cost of a piece part. If carrying charges are added, a still greater variation and alteration occurs.

It seems safe to say that any man or group of men would be incapable of using all these factors quickly and accurately enough manually to take advantage of them on, say, 40,000 unformed steel piece parts. Even more important, if such a task were undertaken manually, a change in piece part requirements, steel pricing, or in any of the other factors mentioned here would cause an immediate change in all final results, and thus require a new study. It was therefore our intent to see whether these formulas, including all of the variables and constants, could be made into one mathematical equation which could be easily solved by an electronic computer.

The first step was to determine mathematical formulas for the steel pricing, shearing, and storage cost, together with the base price of the steel which was required. The following skeleton formula considers these factors:

Total Price Cost =
Σ Base Price of Steel + Width Extra
+ Length Extra + Shear Cost + Storage Cost or
$= C + f(b) + f(a) + f(ab) + f(ab)$

Note that the variables in the final formula are a function of the length (a), width (b), and both length and width (ab) of the steel code size chosen, although the piece part dimensions have an important function.

The solution of the steel purchasing problem is divided into 5 phases.

1. Choosing the optimum code size for each piece part.
2. Combining steel code sizes to a practical minimum.
3. Optimizing the combining of steel sizes.
4. Dividing "buy" of steel to "narrow" and "wide" tonnage allotments.
5. Placing newly released piece parts on the most advantageous steel code available.

The first step of the solution is run on a computer choosing the best code size of steel for each individual piece part using the variables we have discussed, combined with current requirements for the piece part. Once this has been solved, a reduction in the number of steel sizes through some mathematical process is imperative. This requires the use of a semi-matrix type mathematical technique to make

certain that optimum combining is achieved. The formula takes different forms for bars, plates, sheets, or strips because the methods of buying these commodities vary.

The third phase of the program requires that a readjustment of the combining of code sizes be made to fully optimize the combining program.

In the past few years it has not always been possible to buy the size, particularly in width, of steel which is most economical, and tonnage allotments from each vendor restrict the sizes available, due generally to the rolling capabilities of their mills. In the industry, this difference could possibly be defined as "wide" plate and "narrow" plate. When this restriction occurs, it is also necessary to choose a steel size for each piece part on the basis of both narrow and wide plate. When the two alternatives have been made for each piece part, it is then necessary to purchase the least expensive "narrow" steel, to use up the tonnage allotment, by determining those parts which will be least expensive per unit in the overall picture. This is phase four of the computer problem.

Finally, when all piece parts have been allocated to a code size of steel and the proper buy has been made, newly released piece parts must be placed on the most advantageous code size of steel in the register during the "freeze" period of time prior to a new run of the entire problem. This requires testing each code size available to each newly released piece part to determine the best place to allocate it. This then is phase 5 of the problem. The three-dimensional model shown in Fig. 6 indicates the final combination of all the factors we have discussed. It has proved to us that no factor can be ignored in buying steel. Rather, it is the combination of them all — the tug and pull of each variable — which finally determines what set of steel sizes is most economical to purchase.

To Order Paper No. 33B . . .
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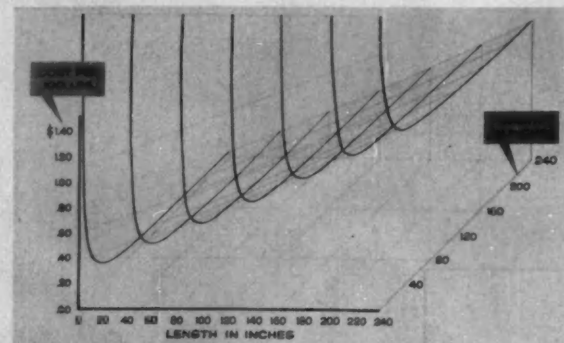


Fig. 4 — Shearing cost for various length-width combinations of steel plate.

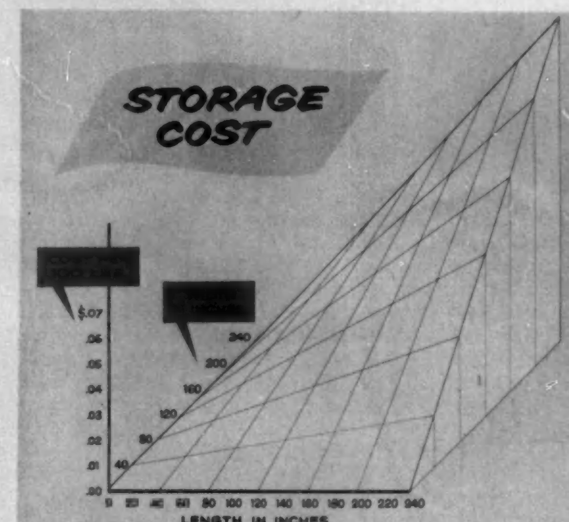


Fig. 5 — Storage cost for a piece part of varying widths and lengths of steel where the requirements for the piece part are 5000 units yearly.

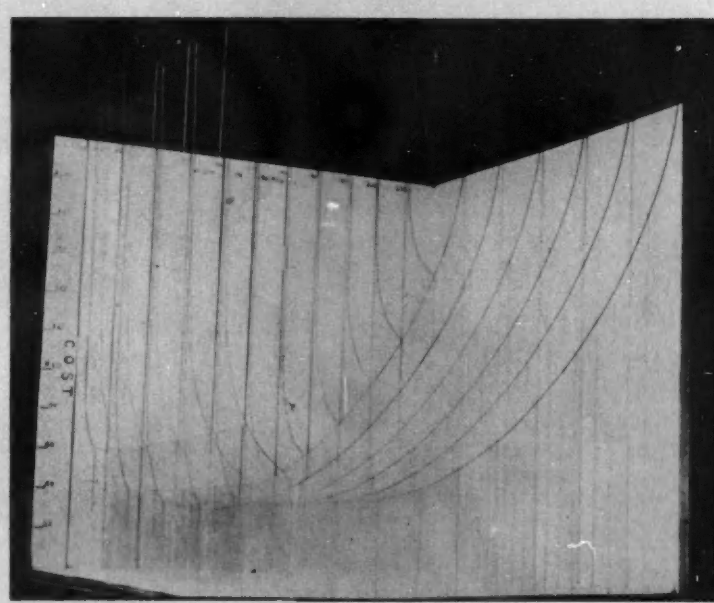


Fig. 6 — Three-dimensional model based on the various factors involved in the steel purchasing decision.

Goodyear's Inflatoplane

By

G. W. Kennedy

Goodyear Aircraft Corp.

GOODYEAR'S Inflatoplane is an inflatable airplane that is easily packaged for transport, but can be quickly inflated and made ready for flight. Its inflatable feature is made possible because of the use of a new fabric structure called "Airmat."

Unlike conventional pressured fabric structure (which normally takes the shape of sphere, cylinder, or other body or revolution, or combinations of these), Airmat can be formed to produce a pressurized structure of other shapes, varying from flat panels to contoured airfoils.

These elements maintain their shape by virtue of the use of "drop threads." These threads connect two surfaces of the structure together and thus maintain a shape that is a function of the drop thread length (Fig. 1). The pressurized vessel develops its structural properties by skin tension, due to the internal pressure, which is limited by the surface tensile strength and the strength and number of drop threads.

The Airmat cloth is woven with two surfaces and drop threads all interconnected as one piece. By coating this material with various natural or synthetic rubbers and additional cover plys, an airtight fabric of proper strength can be obtained. Patterning and seaming this fabric results in a unit that, when fitted with valves and inflated is a structural item.

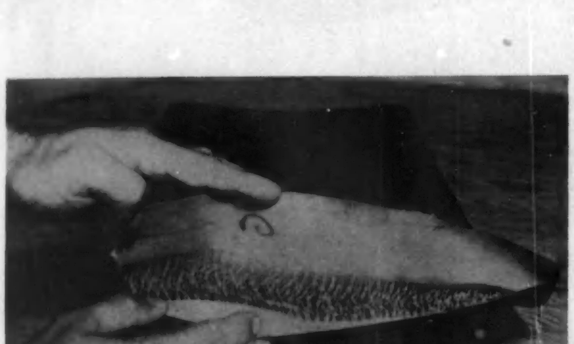


Fig. 1 — Drop thread arrangement in Airmat fabric.

Attachment of rigid components to inflated structures is readily handled by distributing concentrated loads over large areas, using standard lighter-than-air techniques.

Inflatoplanes

The one- and two-place Inflatoplanes are easily packaged for transport, storage, or parachute drop, and are rapidly readied for flight when the time comes.

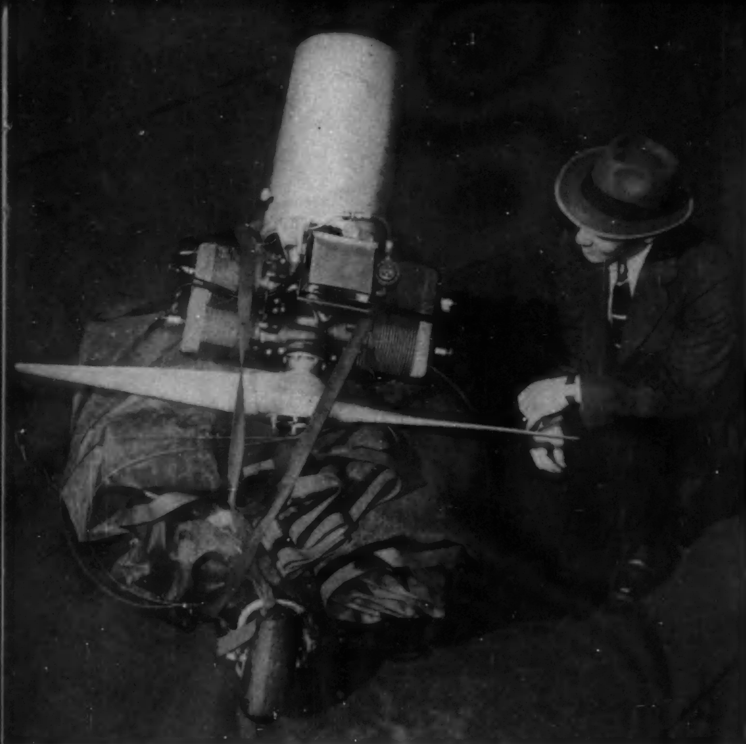
Take-off and landing on land and water are possible in minimum distances and at minimum speeds, making these planes particularly attractive for STOL missions. The main reason for these minimums is the extremely light weight of the fabric structure, which is approximately one-tenth that of conventional materials using the same wing loading.

Inflatoplanes have been subjected to rugged handling, involved in packaged and inflation tests, without fabric damage or deterioration. The fuel cell is a flexible bladder made of Chemigum-coated nylon fabric secured to the inside of the fuselage. It is flexible and is easily packaged with the airplane while containing several gallons of fuel.

Static and wind tunnel tests have been conducted on a flight test model of the Inflatoplane. Ultimate loads have been approached and even exceeded without damaging the inflated components, since excessive loads are removed when compression buckling occurs and the fabric component immediately recovers.

About 125 flights have been made at various altitudes without incident.

Future plans for inflated structures include investigation of high-pressure structures, study of reinforced inflated components to increase stiffness, and development of new airfoil shapes. Results of these investigations are expected to expand greatly the applications of inflated structures in missile and aircraft components.



is a package job,

that is easily assembled, inflated, and

made ready for flight.

CHEVROLET'S

Engineering of its New V-8

Chevrolet has introduced a new 348 cu in. V-8 engine . . . in addition to its currently available 235 cu in. in-line Six and 283 cu in. V-8. This new engine is commonly referred to as the "W."

Excerpts from paper by

John T. Rausch, Howard H. Kehrl, and Donald H. McPherson

Chevrolet Motor Division, GMC

DEVELOPMENT of the W engine which was finally released in the 1958 models — actually started in 1955. In that year Chevrolet built and tested two engines of approximately 300 cu in. displacement. These engines — designated as the X and the Y — had the same basic external dimensions and configurations as Chevrolet's then-new 265 cu in. V-8.

In the X engine, increased displacement was obtained by increasing the bore to 4 in., while retaining the 3-in. stroke. This necessitated joining the bores, creating a difficult casting problem and preventing complete coolant circulation around the cylinder.

In the Y engine, increased displacement was obtained by increasing the stroke from 3 to 3.3 in. and increasing the bore from 3 3/4 to 3 13/16 in. In addition to necessitating completely new tools and equipment for crankshaft machining, these designs would have severely limited further displacement and compression ratio increases that might be required in the future.

In 1956, management approved engineering's proposal to develop an entirely new engine.

Primary Objectives

We decided that the new design must permit:

1. Adaptability to a broad range of displacement with a minimum number of different parts.
2. Adaptability to broad compression ratio range to match the octane trend of future fuels.
3. Dimensions compatible with the anticipated space limitations of passenger-car design.
4. Provisions for mounting accessories on engines for both passenger cars and trucks.
5. Flexibility of machine tools to accommodate future engine modifications.

To get adaptability to a broad range of displacement, we first established the bore and stroke to provide a displacement in line with passenger-car requirements. Then, we determined the bore size that would satisfy our maximum displacement truck engine requirements. The largest bore size then established the bore centers that would provide full circumference cooling and minimum core thickness between bores which would be acceptable to the foundry (Fig. 1).

Valve Arrangement

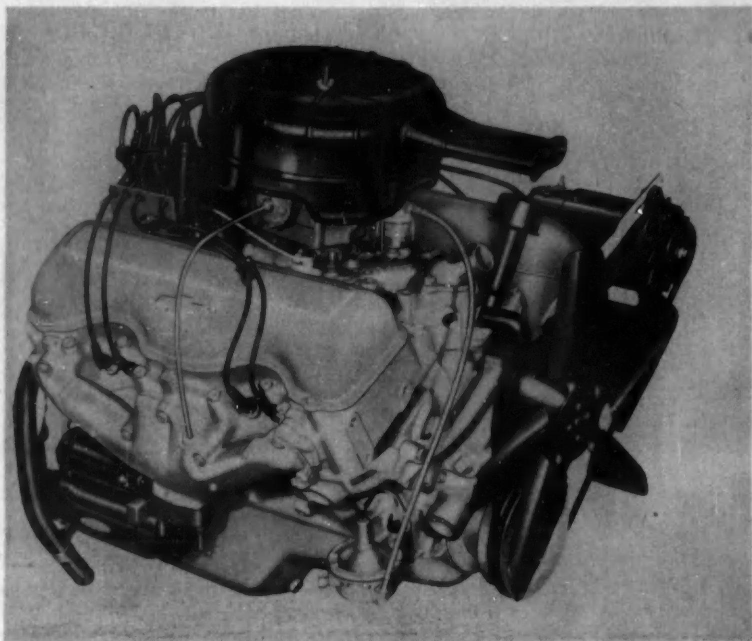
The basic length could then be maintained, provided valves of the size needed for the maximum displacement engine could be placed within the confines of the cylinder, with adequate spacing to insure good exhaust valve cooling and freedom from valve seat distortion.

Staggering the valves allowed for the necessary space while still maintaining the minimum overall length. Flexibility of this design permitted use of a common rocker arm for all the valves.

The required piston proportions, counterweight radius, and connecting-rod established the basic height of the cylinder block.

The established length permitted excellent proportions for bearing length and cheek thickness. These features were combined with large overlapping journals to produce a stiff crankshaft.

To provide for a range of compression ratios, many manufacturing problems had to be investigated. Placing the combustion chamber in the cylinder head, for instance, would require retooling



Turbo-Thrust V-8 Engine—General Specifications

Type	90-Deg V-8
Valve Arrangement	In head
Bore, in.	4.125
Stroke, in.	3.25
Stroke to Bore Ratio	0.79/1
Displacement, cu in.	348
Compression Ratio	9.5/1 (passenger car)
Carburetor	Single 4-barrel
Maximum Gross Horsepower	250 at 4400 rpm
Maximum Gross Torque, lb ft	355 at 2800 rpm
Maximum Bmep	152.3 at 2800 rpm

at the factory every time a compression ratio was changed. Placing it in the head would create a dilemma. For good volumetric efficiency at high speed, space for large valves must be provided. At the same time, the new engine needs to have the highest permissible compression ratio, and latitude to go still higher in the future.

These incompatible requirements would make necessary a compromise at the expense of major cylinder head equipment changes. So, making the cylinder head with a flat bottom and placing the combustion chamber in the upper cylinder bore appeared to have good possibilities. Regardless of what changes might be made in piston shape, stroke, or bore size, the flat bottom cylinder head would remain the same. It would also lend itself to freedom of valve shrouding, to promote efficient flow characteristics. The actual combustion chamber shape could be achieved by contouring the piston head, by angling the top of the block, or by a combination of both. How it was to be done depended on what we believed necessary to establish a sound combustion chamber design:

1. Compactness, for fast burn rate.
2. Adequate quench and squish area, for turbulence.
3. Central spark-plug position, for minimum flame travel.
4. Latitude to obtain different combustion volumes for broad compression ratio range, without affecting piston shape or basic machining equipment.

Inclining the top of the block to 16-deg and shaping the top of the piston like a gabled roof with a 16-deg angle resulted in a 32-deg wedge-shaped combustion space. Approximately one half of the piston top surface and the under side of the cylinder head, which are parallel, provided the desired quench area (Fig. 2).

The addition of two milled cut-outs to extend the

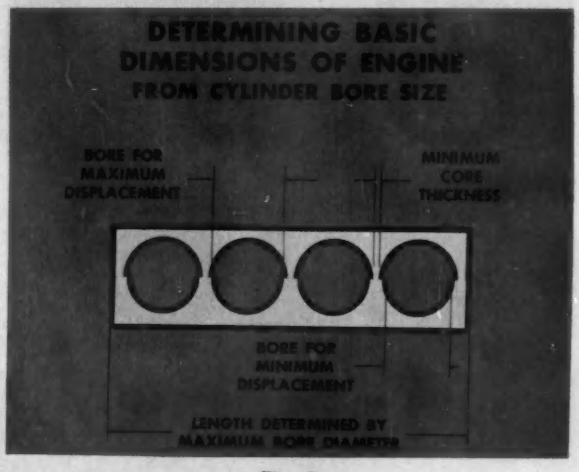


Fig. 1

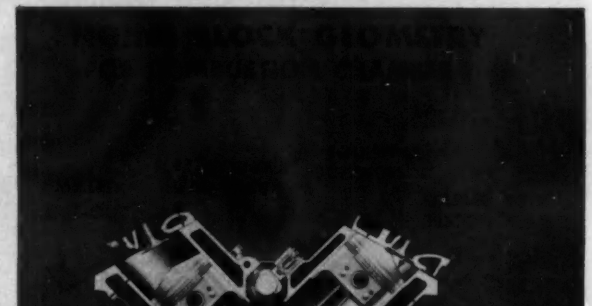


Fig. 2

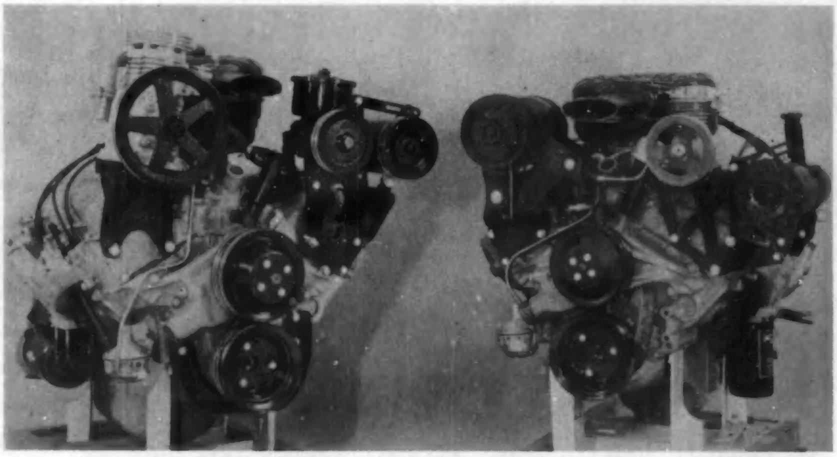


Fig. 3—Left: truck engine; right: passenger-car engine.

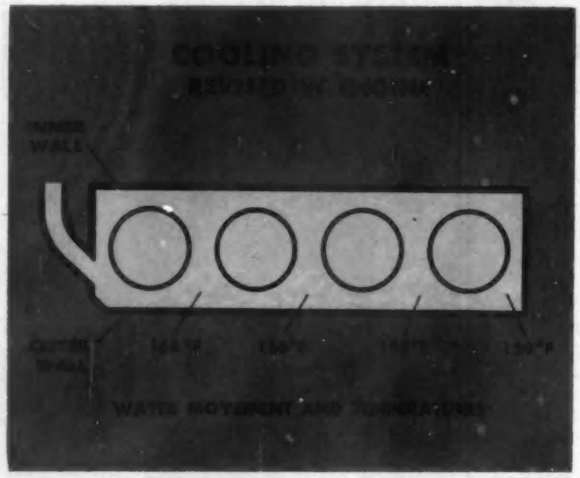


Fig. 4

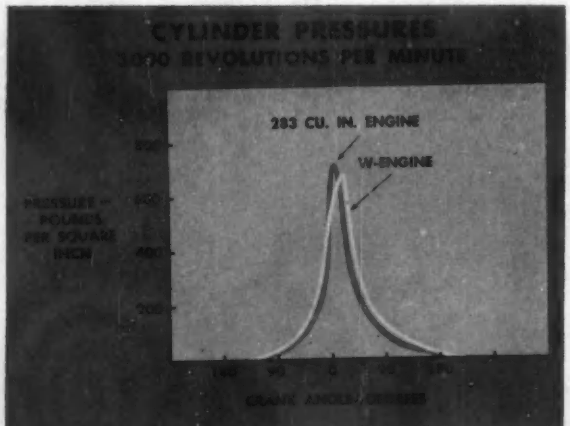


Fig. 5

volume of the combustion wedge can provide a compression ratio of 7.5-to-1; one milled cut-out produces a 9.5-to-1 compression ratio.

That the space limitations were met successsfully is indicated by the fact that the W engine assembly with piston displacement of 348 cu in. is only 1.5 in. longer and 2.6 in. wider than the 283 cu in. engine assembly. In height, we were able to effect a decrease of about 0.8-in.

Accessory Mounting

To provide mountings for accessories, it was necessary to make composite studies of mountings for all the accessories deemed necessary for passenger cars and trucks.

Placing three tapped holes in the end wall of the cylinder head and two tapped holes on the top of the inlet manifold made it possible to install durable mounts and brackets. These points of attachment are used to mount the compressors for air conditioning and Level Air ride for passenger cars and to mount the air brake air compressor and the power steering pump for trucks. (Fig. 3).

The group of three holes is placed at both the front and the rear of the cylinder head to eliminate the need for a right- and left-hand unit.

We believe we have taken a long stride toward achieving maximum flexibility in the use of automated manufacturing equipment, with resultant long-range economy.

Development Program

This completed the conception and initial design phase of our W engine program. Chronologically, we were now at the point when the first prototype engine was completed and ready for laboratory development.

The most serious questions that were recognized at this point were the following:

1. Was the basic combustion chamber design satisfactory from the standpoint of specific power output, fuel octane requirement, and fuel economy?
2. Would the location of the combustion chamber

inside the cylinder block produce any special cooling problems requiring major tooling changes?

3. Would the larger piston crown area result from the gabled head design increase piston temperatures and durability problems?

It was first necessary to insure adequate combustion chamber cooling.

Forty thermocouples were installed in the first engine at suspected localized hot spots.

It was not possible by this means alone to eliminate hot spots adjacent to the combustion chamber surfaces.

Inasmuch as water temperature is only a secondary approximation to heat transfer at a given point in the cooling system, the top deck of the cylinder head was removed and replaced with a plexiglass sheet for visual observation of water flow patterns. Visual observation of water flow in these areas confirmed our suspicion that there was very little turbulence and therefore poor heat transfer in the hot spot areas.

An experimental modification was made to the water pump to direct the coolant discharge along the outer edges of the cylinder block. This arrangement showed a major improvement in turbulence in the critical areas and also eliminated the hot spots. Fig. 4 shows the turbulence patterns and typical temperatures with the modified water inlet. This arrangement was then released to production in place of the original design.

Performance Characteristics

Our next objective was to determine whether the performance characteristics of the combustion chamber were satisfactory. Dynamometer measurements of brake mean effective pressure, leanest best torque fuel requirements, minimum spark advance for best torque, and borderline knock characteristics indicated satisfactory combustion chamber performance in compression with our 283 cu in. engine.

Combustion chamber pressure cards were obtained and compared to our 283 cu in. engine. Fig. 5 shows the comparative pressure cards; the indication was that combustion chamber characteristics would be satisfactory. Mbt spark requirements, as shown in Fig. 6, also were found to be acceptable.

Piston Durability

The next area of concern was durability of the gabled head piston design.

To verify that high piston head temperatures would not present a serious problem, actual piston temperature measurements were made. Comparison revealed that piston temperatures were higher in the W engine than in the 283 cu in. engine. The difference, however, was not greatly more than might be expected with the greater heating to cooling area ratio inevitable from the larger piston diameter alone.

At this time it was felt that sufficient development

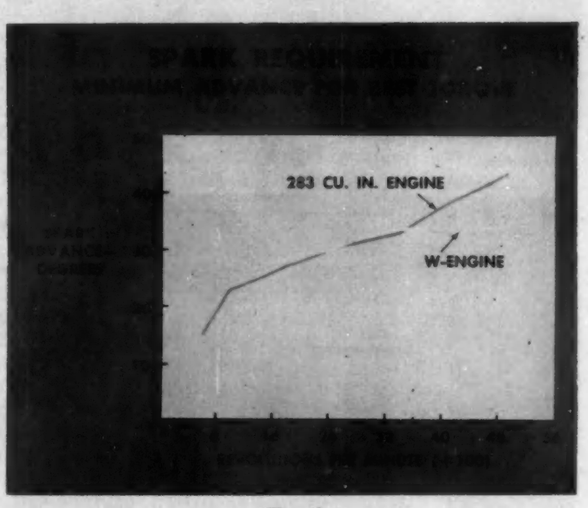


Fig. 6

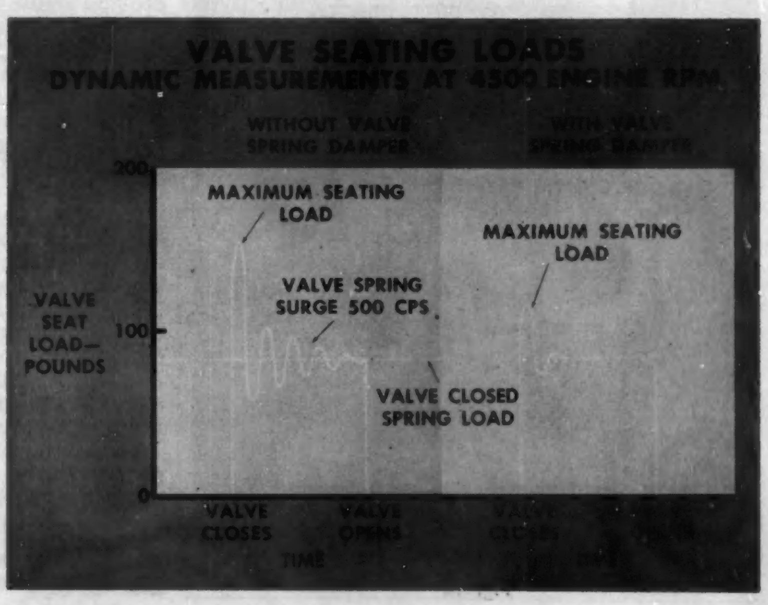


Fig. 7

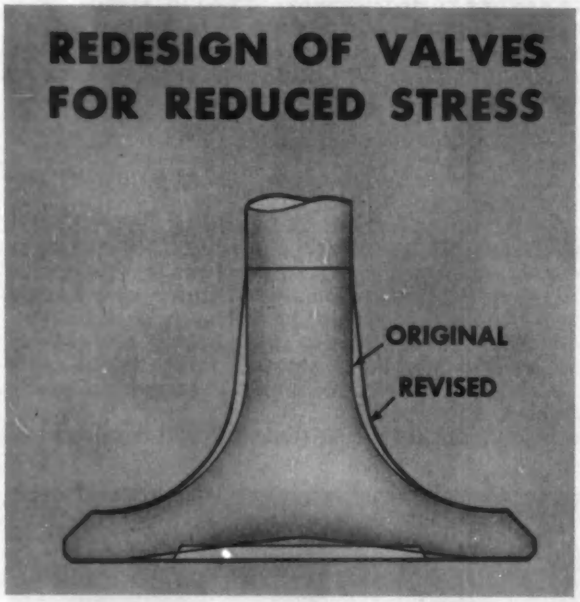


Fig. 8

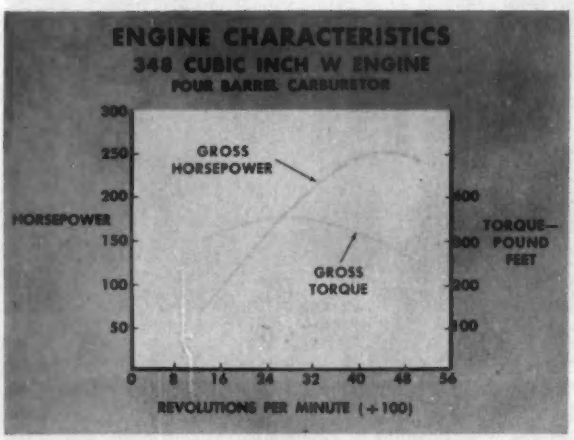


Fig. 9

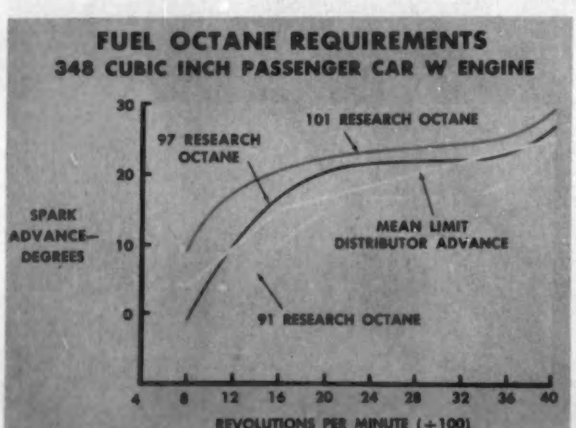


Fig. 10

work had been done to predict that the basic engine design would make a satisfactory product. This was also the point of no return in so far as the production tooling was concerned, as the basic production machinery was on order. If we made any major engineering changes from this point on, we would incur large cancellation charges and possibly find it impossible to meet production deadlines.

Most of the remaining development problems were solved by conventional techniques. However, certain aspects of the programs relating to valve train, camshaft selection, crankcase ventilation system, and electrical system are worthy of discussion.

Valve Train

The valve train is similar to that used on the 283 cu in. engine, with the exception that the rocker arm ratio has been increased from 1.50 to 1.75. This change reduces the effective inertia of the push-rod and valve lifter, and also makes possible a substantial increase in cam nose radius, with a resultant reduction in contact stresses. Modifications to valve springs, valve lifters, and valve train rigidity resulted in a final limiting speed of 5400 rpm. (Limiting speed is defined as the speed beyond which the engine will not develop satisfactory power due to valve train malfunction.)

With the dampers installed, the valve spring oscillations are quickly damped out, with a resulting improvement in valve train quietness and durability (Fig. 7).

An additional factor of safety was obtained by a design modification to eliminate a stress-raiser where the valve step grind run-out blends with the under side of the valve head (Fig. 8).

The final selection of the camshaft was based on a study of overall powerplant characteristics in combination with the Turboglide transmission. The speed range from 2400 to 3200 engine rpm was found to be vital in producing good low speed and midrange performance; therefore an effort was made to provide ample torque in this speed range. The final powerplant performance accomplishes this objective, as shown in Fig. 9.

Early vehicle tests disclosed a serious hot cranking problem caused by self-ignition of the fuel prior to the normal spark-ignition point.

Modifications were made to the starting system on the basis of tests until we finally selected a system consisting of a series-compound wound starting motor and an 11-plate 60-amp-hr battery. This starting system provides satisfactory hot starting at water temperatures up to and including 240 F, and also performs well during cold starting.

Fig. 10 shows the full octane requirements of an engine with representative combustion chamber deposits and cooling water temperature at 190 F. A gasoline with a Research octane number of 97 satisfies the engine's requirement throughout the usable speed range.

Design, development, and timely release by production of the engine have been the outcome of cooperative effort by Chevrolet design, laboratory, and manufacturing groups.

To Order Paper No. 32C . . .
. . . on which this article is based, turn to page 5.

Boron ∻ Hydrogen ∻ Carbon . . .

form fuels of high heating value that may make possible missions which couldn't be accomplished with other fuels. But the tailor-made boron compounds are costly.

Based on paper by

Robert J. Heaston

Propulsion Laboratory, Wright Air Development Center, USAF

ELEMENTAL boron has a high heat of combustion, approximately 25,400 Btu per lb, and forms with hydrogen a series of compounds known as boranes. The most representative of these are diborane (B_2H_6—gas), pentaborane (B_5H_9—liquid), and decaborane ($B_{10}H_{14}$—solid).

These boranes all have heating values greater than 28,000 Btu per lb, but are difficult to handle and lack the most desirable fuel traits. However, adding carbon to the boron and hydrogen imparts a stabilizing effect and forms attractive fuel compounds. Fuels analogous to the hydrocarbons are formed which might be called "alkylboranes," "carboboranes," and/or "carboranes."

Project ZIP, a large-scale research and development program aiming at preparation of suitable carboranes, was launched by the Bureau of Aeronautics, Department of the Navy, in 1952. Many new substituted boranes were prepared as the fruit of work by two prime contractors, the Mathieson Chemical Corp. and Callery Chemical Co. with the support of several subcontractors. A major achievement was the preparation and identification of alkylborane in November, 1953. This was a derivative of decaborane. It possesses many desirable fuel properties and has led to a class of high energy fuels. Comparison with an advanced hydrocarbon, JP-6, is shown in Table 1.

Other chemical and physical properties are essentially the same as for accepted hydrocarbon fuels. The basis for measuring the heating value and specific gravity characteristics are easily interpreted, but the reactivity and thermal stability are not. The reactivity represents the order of magnitude difference between the flame speed of HEF and JP-6. The thermal stability of 500 F represents an upper level for residence time of less than a minute with little or no solids formation. This characteristic varies considerably with other temperature-time correlations ranging from long-time storage at normal conditions up to the limit given.

High Cost of Production

Properties of the new carborane fuels suggest a wide field of application, but this is not the case. Use can be achieved only where the greatest advantages can be realized or where a mission cannot otherwise be performed. This is so because of inherent economic factors. Carbon-boron-hydrogen fuels are obtained only through complex chemical technology. A boron ore must be changed by energy from coal, oil, or electricity to some intermediate. Then carbon is added through a hydrocarbon, or other means, to form the final product. This involves several approaches.

About 90% of present facility and production costs are involved in the preparation of intermediate diborane. This is then heated and pyrolyzed to other boranes and finally alkylated to a high energy fuel. An alternate approach is to alkylate the diborane and then pyrolyze the products to the end fuel. This overall complexity adds considerably to cost. It is estimated that practical application of the more unique processes of production on a tonnage basis could make the cost per pound about 65¢ to $1.00 for the carboranes as compared to 4¢ per lb for hydrocarbons.

Productive facilities have been expanded to provide boranes for evaluation and all of the output will be used for research. Production could range from a few tons per day to several hundred, depending upon requirements.

To Order Paper No. 41A . . .
. . . on which this article is based, turn to page 5.

Table 1—Properties of JP-6 and High Energy Fuels Compared

	JP-6	HEF
Thermal Stability, F	500	500
Specific Gravity at 70 F	0.78	0.82
Heating Value, Btu/lb	18,600	Greater than 25,000
Reactivity	1	6-10X

3 New Forging and

. . . provide high-strength,

Based on paper by

John F. Murphy

Curtiss-Wright Corp.

• Precision gear-forging process

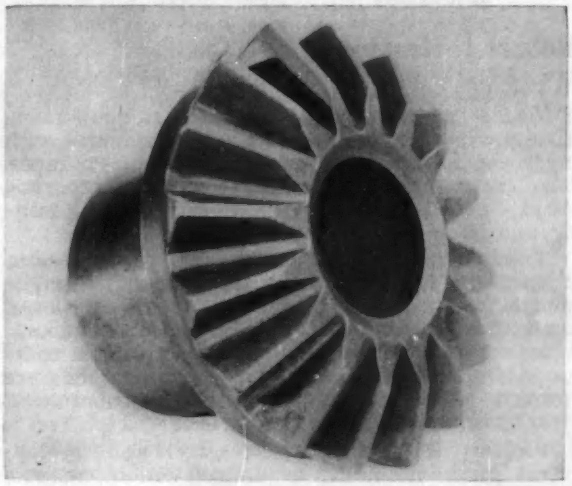


Fig. 1 — Differential side gear produced by the precision gear forging process. Tooth strength is greater than with machined gears.

1. THE PRECISION GEAR-FORGING PROCESS

A new low cost method of finishing dies enables forged precision gears to compete economically with machined gears. In addition, the preferential grain flow of the forged gears provides greater tooth strength than is obtainable with conventional machining processes.

A conventional hot-forging process shapes the gears. A screw press, however, replaces the usual crank press. This arrangement provides slightly greater impact than the crank press but not as much as a drop hammer.

Bolster plates and die-holding mechanisms give maximum rigidity and strength. Knock-out mechanisms, located both on the ram and the anvil, strip parts from the dies with each stroke of the press.

Dies

The dies are designed as inserts, thus providing the smallest possible requirements of costly die steel. The inserts are round and the clamping mechanism designed so that the dies can be changed in less than ½ hr.

Die materials are hot-work die steels, and are roughed out by conventional machining processes. The die is hardened and then finished using a process, which results in a highly accurate die. Little labor is required by this finishing practice.

When dies are worn, they may be returned to the finishing process and completely reconditioned. The accuracy of the dies may be reproduced within the tolerances required to produce precision forgings.

Die life is relatively short, but many reworks are possible at low cost.

Materials

The materials commonly used for gear forgings have been the normal carburizing grades of steel. Some experience has been gained, however, with the through-hardening grades of steel and with tool steel, but insufficient information is available on these at this time. Parts made of stainless steel show excellent results.

Configurations

Bevel gears, both straight and spiral, form the major portion of production at present. Pinions as small as 1 in. in diameter and hypoid ring gears as large as 8 in. in diameter have been produced however. Fig. 1 shows a typical forged differential side gear.

The maximum strengths and best noted properties have been found in gears having a pitch less than 12. The greater amount of metal working necessary to forge these gears probably accounts for this fact.

Small cogs, ratchets, cams, and milling cutters have also been produced by this process.

Tolerances

The tolerances available with this process satisfy most applications without any additional work re-

Extrusion Methods

high-quality, low-cost parts:

• Rotary forging process

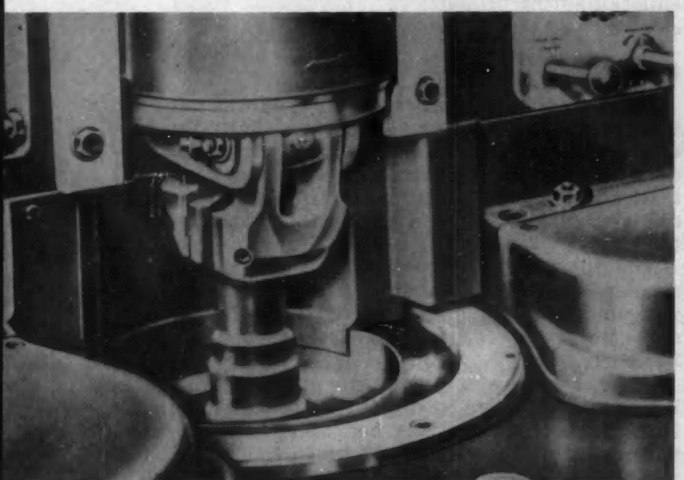


Fig. 2 — Workpiece clamped in the jaws of the machine used in the rotary forging process. The workpiece rotates and is beat into the desired shape by four horizontally-opposed hammers.

• Cross-extrusion process

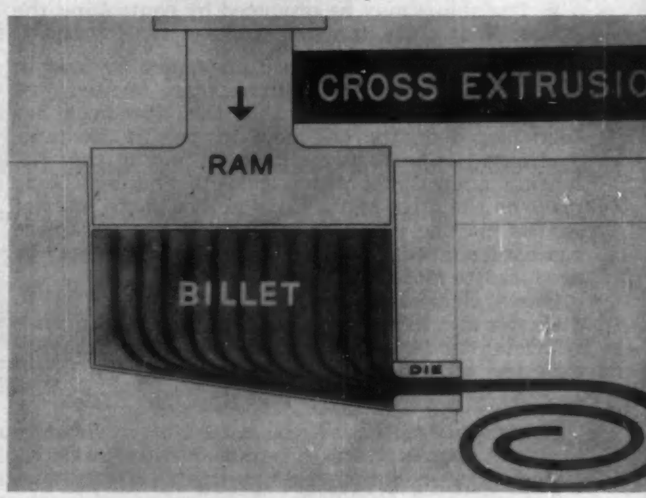


Fig. 3 — Principle of the cross-extrusion process. The material is forced to make a 90 deg turn which results in better physical properties and makes the material superior for springs.

quired on the gear teeth. Normally, minimum tolerances in pitch diameter, tooth profile, tooth spacing, measurement over several teeth, may be stated as 0.0015 in. The accuracy of the die is a controlling factor in part dimensional stability. Thus the die must be in excellent condition when put into service, and must be maintained to insure that the close tolerances be produced in the part dimensions. Normally this would be economically unfeasible, but the die finishing process used makes this a favorable economic process.

Decarburization is controlled by the use of atmosphere furnaces. An outstanding characteristic of these gears is that they do not go out of tolerance during carburizing and heat-treating. This is probably due to the controlled cooling rate which produces a fully annealed part. It should be noted here that the teeth and the face of the gear are the only sections which are actually precision forged. The hole is machined and the back face of the gear where flash collects is faced at the same time as the hole is drilled. To maintain tolerances during these machining operations, fixtures have been developed which locate from the teeth and provide excellent holding power while machining.

Physical Properties

Tooth strength, in all cases, has shown substantial increases over normally cut gears. In one case, an increase in tooth strength of over 100% was noted in comparing the precision forged gear with a similar gear which had been machined from a rough forging.

The preferential grain flow up around each tooth as well as the normal longitudinal grain flow has produced this increase in strength. Unfortunately, the high speed fatigue strength, as yet, has not been adequately measured.

Economics

This forging process will not compete with the Revacycle or hobbing machines where a stack of gears may be loaded into the machine and one

operator takes care of several machines.

In the case of aircraft gears where many operations are required and the maximum in strength may be utilized, this process results in cost reductions up to 25%. The economics are outstanding where costly materials such as high temperature alloys or titanium must be used.

2. THE ROTARY FORGING PROCESS

A newcomer to the field of precision forging is the rotary forging technique. In this process, a machine holds the workpiece vertically and rotates it while four horizontally-opposed hammers beat the workpiece into the desired shape.

The shape is controlled in two ways:

1. The shape may be machined into the hammer.
2. The shape may be produced by controlling the length of the hammer stroke.

Fig. 2 shows the workpiece suspended by jaws in the rotary head. The hammers are located just beneath the housing. In this case, the work has been forged on the end now gripped in the jaws. The part has been turned end for end so that the forging operation on the opposite end may take place on the same heat. With hollow parts, interior shapes may be produced by forging the workpiece against a shaped mandrel. Intricate shapes may be produced to close tolerances.

One typical machine takes solids up to 4 in. in diameter and hollow parts up to 5 in. OD. Length is restricted to 39 in. The tolerances which may be expected with the machine are:

	Hot	Cold
Outside diameter, in.	± 0.012	± 0.004
Inside diameter, in.	± 0.004	± 0.0004

Note that differences are spelled out for hot and cold working. Hot in this case refers to the normal forging temperatures encountered with a given material. Most work is done hot when the maximum movement of stock is desired. Scale-free heating is a must if a high quality surface is to be produced on precision forgings. Cold forging refers to room temperature working of metals. Cold forging is done normally when a high precision internal shape is desired.

Quality

This process has produced parts of consistent high quality. Normally, a greater amount of metalworking occurs with this process than with conventionally forged parts. This contributes to a higher strength and more uniform grain flow. Often, this process has produced parts normally made from bar stock. In such cases the properties have shown decided improvement.

Economics

Material is conserved by the rotary forging process. Weight savings up to 54% have been realized. Tooling for the rotary forging machine is relatively cheap—often less than one-tenth the cost of tooling for conventional forging equipment. Machining costs too are usually substantially lower than with conventional forging processes.

3. THE CROSS-EXTRUSION PROCESS

In the cross-extrusion process, the material to be extruded is placed in a heavy container with a die opening at 90 deg to the axis of the billet. Pressure is applied to the billet in line with its longitudinal axis and the extrusion is produced through the die at 90 deg to the direction of the applied force. Fig. 3 shows the basic principle of the process. The actual tooling is rather complex but may be broken into the essential elements shown.

Forcing the material to turn corners results in additional break-up of the normal directional flow lines. This brings longitudinal and traverse properties closer together and results in a material with superior spring properties.

Properties

One product that was cross extruded was designed to be 0.410 in. diameter round wire. Initially, wire of extremely poor surface finish and shape was produced. Only after repeated trials using variations in heating media temperatures, die materials, and die configurations was a successful round wire extruded.

The tolerances were ± 0.007 in. as extruded diameter. Ovality was within 0.015 in., and the finish was about the same as hot-rolled standards. Decarburization was measured at less than 0.001 in. in depth.

Springs were wound using the extruded wire after it had been finished by drawing and heat treat. Although no life data has been obtained on these springs, they have withstood an initial 150 hr. test and will be further tested for service life at Wright Aeronautical Division.

From the initial bench run, it appeared that the material was very good and that development of better methods of producing cross-extruded wire should proceed.

Economics

When the quantity of material to be produced is too small to economically justify the setting up of a rolling mill, cross extrusion will show advantages because of low tool cost. In other cases, a lower grade of material for instance; a cast billet might be cross extruded to provide an end product equal to or better than a forged and rolled product. In certain cases, it has been shown that it will be possible to obtain outstanding characteristics. An example was an increase in tool life of 50% when cross-extruded tool steel was compared with conventionally processed material.

This indicates that an economic analysis must be made for each application. At this time many materials are being evaluated. Cross extrusion is proving too costly for many applications where normal commercial stock may be used. However, many specialized alloy applications look very promising.

To Order Paper No. 36C . . .
. . . on which this article is based, turn to page 5.

Abridged from an
SAE Montreal Section Paper

Caliper Disc Brakes—

having proved their worth on sport and racing cars, will be widely used next year on British and European passenger cars, trucks, and buses. Here's a short description of the two principal types.

Based on paper by

S. E. Sherlock

Girling, Ltd.

THERE are two principal types of caliper suitable for direct hydraulic operation—the reaction type and the opposed-piston type, as shown in Fig. 1. In both types the function of the caliper is to provide clamping loads to the friction material on opposite sides of the disc with minimum deflection.

Reaction Caliper Design

The reaction type has hydraulic actuation on only one side of the disc and the disc must slide axially during braking. The caliper must be mounted on a hinge or slide on pins so that it can move squarely to an axial located disc. The Goodyear brake fitted to Indianapolis race cars illustrates the hinged reaction caliper.

This type has two shortcomings. It is difficult to provide an economic or satisfactory mounting, and the bridge of the caliper takes up more room over the edge of the disc. The Citroen DS-19 uses reaction type calipers for the front brakes, but these are mounted inboard where space is not as critical a factor as it is when mounting in the wheel.

Opposed-Piston Caliper

The problems of mounting and space caused us to adopt the opposed-piston caliper. From 1951 to 1953 we used a form having two or three pairs of opposed pistons with cylindrical friction pads working in the hydraulic bores. Calipers were made of iron castings, aluminum alloy castings, aluminum bronze die castings, pressed steel, and finally copper-brazed slab steel. This last proved the most rigid and had a stiffness of 0.0007 in. per 1000-lb load on each side of the caliper.

Fade resistance was phenomenal, but lining life was inadequate and there were serious service problems. There was failure of the hydraulic seals as they passed over dirty bores previously occupied by the lining material, and there was need to remove the caliper to replace worn linings.

Segmental Pad Caliper

The segmental pad caliper was adopted in 1953 for four sound reasons: uniform heat dissipation, simpler construction, reduced risk of hydraulic failure, and quick lining inspection or change. (See Fig. 2.)

The segmental pad dissipates the energy more uniformly across the braking path, which is highly important because the mean rate of energy dissipation during a maximum braking application can be as much as 10 hp per in. of lining. The pads give the maximum utilization of a given braking path width, with benefit to lining performance and wear, and to the disc. When circular pads are used, wear on the disc is concentrated in the central part of the braking path and serious thermal distortion of the disc often occurs on heavy-duty applications.

More lining area can be operated by a single pair

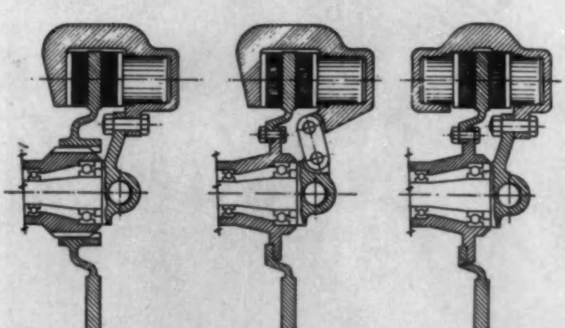


Fig. 1—(Left) Reaction caliper with sliding disc, (center) hinged-type reaction caliper with axially located disc, (right) Girling opposed-piston caliper.

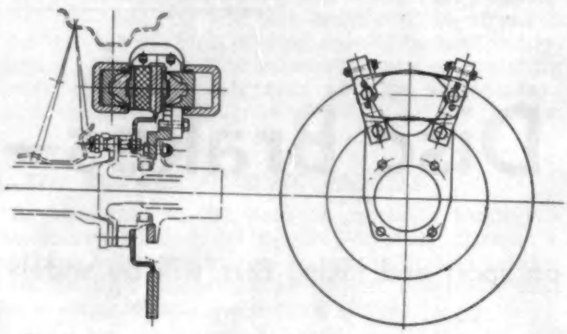


Fig. 2—Segmental pad caliper for passenger cars has forged steel stirrups with bolted-on light alloy cylinders and segmental linings bonded to steel-backed plates. Lining pad on right-hand side is shown in fully worn position, while pad on the left side is new.

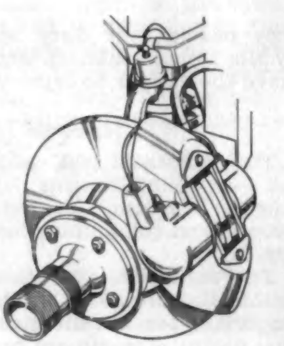


Fig. 3—Integral body caliper used on front brakes of all production Triumph TR 3 sport cars..

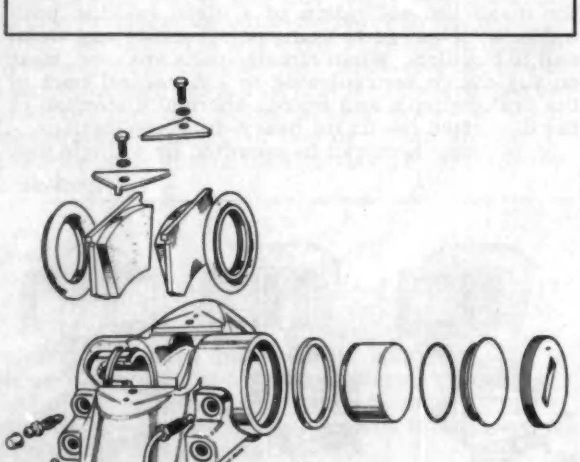


Fig. 4—Car-type integral body caliper. Segmental linings are bonded to plates of near-rectangular form. Open end of the caliper required for machining is sealed by an O ring, seal carrier, and screwed plug.

of pistons than by the three pairs previously used, and there is an obvious economy in production.

With the segmental pad caliper the hydraulic bores are not fouled by dirt, lining dust, or water. This reduces the risk of failure and the necessity for servicing. Moreover, the hydraulic fluid is further from the disc, thus reducing the risk of vaporization.

Finally, the opening in the caliper bridge allows easy inspection of the lining as well as quick changing of the lining pads. During the Sebring race of 1956, a lining change was made on an Aston Martin while it was making a pit stop for wheel changing and refueling.

Commercial Vehicle Application

Large calipers having two pairs of bores have been fitted to some 300 single-deck vehicles operated in the Birmingham area of England. The vehicle carries 42 passengers for an all-up weight of 18,000 lb. A common caliper is used for front and rear brakes, one per wheel, and a disc brake for parking is used on the transmission. With the vehicle fully laden, decelerations of 75%g were obtained, and at the end of 200 fade stops from 30 mph, using a constant pedal effort, there was a reduction of only 10% in braking efficiency. The weight of the disc brake installation is 164 lb less than that of a comparable shoe brake installation. A considerable number of vehicles have completed over 150,000 miles of travel in a densely populated area without any brake maintenance other than brake lining pad change. Replacing fully worn lining pads on all wheels can be done by one man in one hour, compared to five or six hours for replacement of shoes. It is easy to check for wear and no adjustment for lining wear is necessary because of the hydrostatic principle of self-adjustment.

Production costs have been lowered by adopting an integral construction of caliper body in cast iron, and by eliminating the thrust block between the piston and the pad backing plate. This type, shown in Fig. 3, has been fitted to all standard production Triumph TR3 cars since 1956. The piston bears directly against the steel pad backing plates with acceptable deflection. The hydraulic bores are doubly protected against corrosion and dirt by the position of the seal at the mouth of the bores and by the rubber boots (Fig. 4). The boots also keep the piston clean as they follow up lining wear, so that they can be pushed straight back to the bottom of the bores on relining without risk to the seals.

Simplification for Production

The caliper is now being made in two halves, bolted together on the centerline, as shown in Fig. 5. This construction facilitates machining and eliminates the screwed end plug of the integral caliper, thus reducing slightly the axial length of the caliper. Equal stiffness has been obtained for less weight.

The position of the caliper is important. It should be mounted on the horizontal centerline of the axle at the trailing side. This keeps the loads on the wheel bearings to a minimum since the braking force on the disc is opposed to the vehicle load on the axle.

Commercial vehicle calipers are also being made in two halves, the halves being iron castings. On each side of the disc there is one pad assembly operated by two pistons. The size shown in Fig. 6 is adequate for an axle weight of 10,000 lb, while two calipers per wheel can be used for a 20,000-lb axle. Prototype truck installations with two calipers per rear disc and one per front disc are operating satisfactorily.

Parking Brakes

Hand brakes on passenger cars should not detract from the automatic adjustment feature, which is provided so simply on the main service brakes. One common approach is to fit a distinctly separate mechanical brake to the rear discs for parking, either as a separate caliper or as an appendage to the rear caliper, as shown in Fig. 7.

In the early stages of development, discs were made from mild steel forgings and the brake paths hard chromium plated to a thickness of 0.002–0.003 in. These were expensive. Further work showed grey cast iron discs to perform satisfactorily in combination with available lining materials provided consideration was given to the shape of the center part of the disc. Straight discs cracked across the segment holes under conditions producing high disc temperature. Where the mounting face has to be substantially in plane with the braking path of the disc, the convoluted form has been effective in avoiding thermal failures, by providing radial flexibility similar to that obtained automatically in the more usual dished center form.

To Order Paper No. S66 . . .
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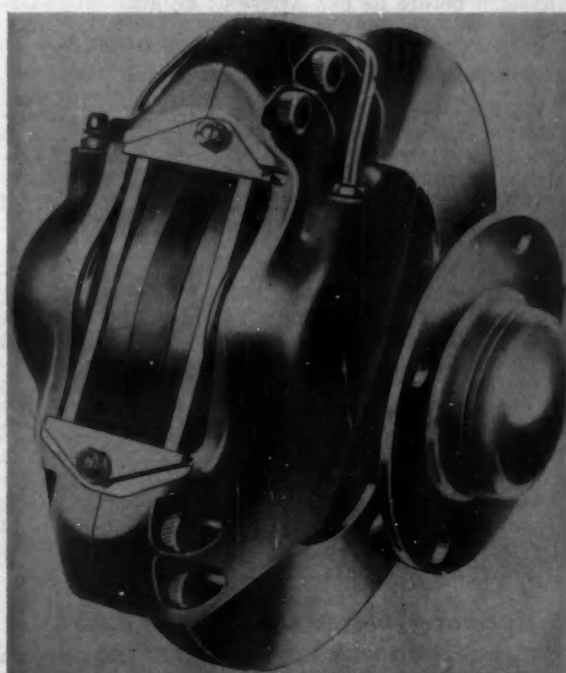

Fig. 5—Split caliper used on front brakes of Aston Martin DB2-4. The two halves of the caliper are held together with high tensile bolts.

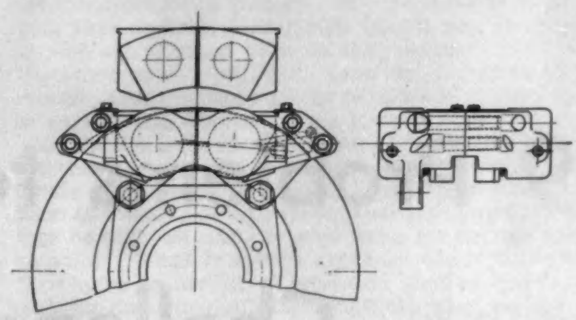

Fig. 6—Split caliper for commercial vehicles has two pairs of bores on each side of the caliper. One pad assembly out of a caliper is shown to illustrate two segmental linings on one backing plate.

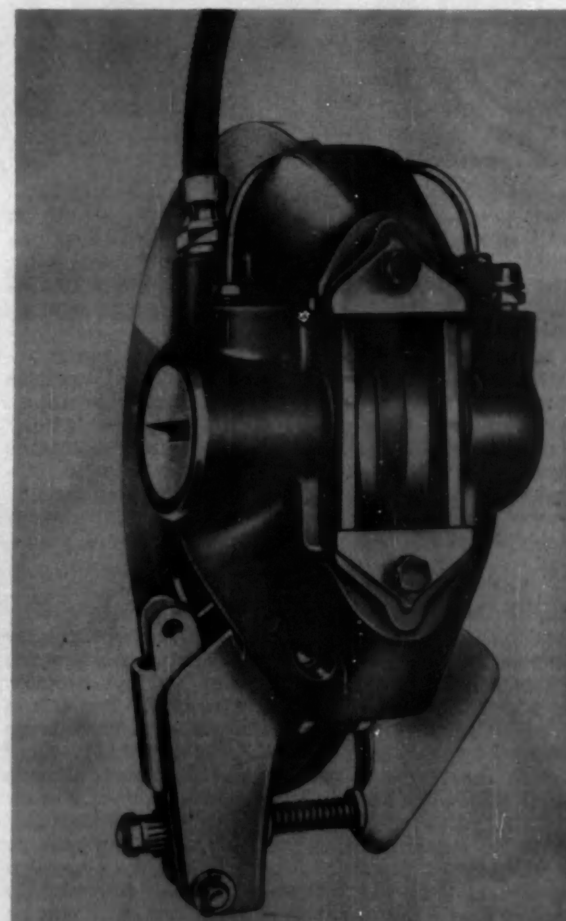

Fig. 7—Car-type rear caliper with hand brake. Two main clamping levers pivoted in caliper body, clamp separate circular lining pads to each side of disc. Clamping levers are drawn together by adjustable tension rod passing over edge of disc.

9 Problems to Challenge Tomorrow's

Based on talk by

C. C. Furnas

Chancellor, University of Buffalo

1 Supersonic Commercial Flight

Preliminary designs of supersonic transport aircraft to cruise at 1500 mph have been made, but as yet there have been no serious attempts at development. Why not go the whole way to rocket ships, which will travel far above the atmosphere at 15,000–20,000 mph and then glide down through the atmosphere at the destination?

Long-range guided missile experimentation is beginning to demonstrate that large rocket vehicles can travel to very high altitudes and long ranges. Why not use them for passenger transportation? Can some of the present-day, grave hazard problems be adequately solved? Since such travel would necessarily be in completely sealed cabins, the passengers may present some psychological as well as physiological problems. Are these solvable?

2 Vertical Take-off Aircraft

If take-off and landing distances could be greatly decreased, it would be feasible to have airports much closer to the center of population. Is it possible to do this? The technical answer is "Yes." But if you phrase the question as, "Is it feasible to have large transports capable of vertical landing and take-off?" the answer is "Not yet." The final answer rests primarily in the powerplant.

Despite the remarkable decrease in weight of aircraft powerplants, they are still not of sufficiently light weight per pound of thrust to make a vertical or even a very short take-off feasible for heavily loaded fixed-wing aircraft. If the weight could be cut by half, or more, this type of aircraft could operate in and out of relatively small spaces. This is the challenge.

Perhaps the path for this lies in the direction of the ducted fan or shrouded propeller powerplant, which has been neglected here because it lacked outstanding military utility. Perhaps some entirely new line of approach is needed.

3 Aircraft Noise

This is a severe problem that is going to become increasingly serious. What can be done to suppress aircraft noise in population centers?

Probably the mechanical engineer is going to have to lean heavily on the knowledge of the fundamental physicist before he can arrive at an adequate solution.

4 Air Traffic Control

We are coming to a critical point in air travel. The air space around the major centers, such as New York, Chicago, and Los Angeles, is already saturated at hours of peak traffic. Just a little more crowding and we are going to have a number of tragic accidents or a great degradation in the reliability of schedules.

According to a study made by the Special Assistant on Aviation Facilities Planning, appointed by the President in 1956, most aircraft will be flying under a tight air traffic control system by 1975. To meet this need, a ten-fold increase in the traffic-handling capacity of our present control system will be needed. It will call for extensive research and development in ground radar, automatic control systems, anticollision radar, and computers. It will be very expensive and difficult, but necessary if air traffic is to rise to its logical potential. The aeronautical engineer, the electrical engineer, and the physicist will have to work together closely to arrive at adequate solutions.

5 Nuclear-Powered Commercial Aircraft

Engineers are going to be faced with this problem before many years. The heavy shielding weight required for the powerplant is a very serious handicap. Development of a nuclear powerplant for

Abridged from talk before
SAE Metropolitan Section

Engineers

large military aircraft is being supported jointly by the U.S. Air Force and the Atomic Energy Commission. Progress is slow but in the positive direction, and plans are being laid for an airplane to use the powerplant.

Even if such an airplane is successful for military purposes, it may not be commercially usable, primarily because of the radiation hazard. The physicist may be able to contribute to the solution through finding lighter weight shielding materials. The physiologist and the biologist will be involved in any serious developments.

6 Railroad Survival

Since World War II passenger traffic on railroads has declined almost one-half, and while freight tonnage has held up fairly well, it has fallen proportionally until now the railroads carry less than one-half of the freight of the country. It would be an economic tragedy to have the railroads go the way of the horse and buggy. There are some things they can do better than any other form of transportation.

The railroads have been meeting the challenge of the passenger car, truck, airplane, and pipeline by various economies. They have slashed passenger service, torn up miles of slightly used tracks, substituted diesels for steam locomotives, and developed mechanical devices for track maintenance. Rail executives may be partially correct in blaming many of their troubles on unfair tax structures and obsolete regulatory practices, but are there not any untried possibilities of technological rescue?

Transportation engineers should look assiduously for answers. How about still more economical powerplants, more suitable car design, cheaper track maintenance, and more efficient, acceptable operating methods? These questions constitute a technological challenge of the first magnitude.

7 Highway Traffic Congestion

With about half of the almost one trillion passenger-car-miles per year in private cars traveled on city streets, the question where to park is approaching a metropolitan tragedy. Are the congested centers, such as lower Manhattan Island and the Loop in Chicago doomed because they cannot adapt to the automobile? Will it be necessary to replan and rebuild metropolitan centers completely if they are to survive the impact of the automobile?

At the moment, these questions are unanswerable, but they are posed because they are pertinent to the future of engineers who are dealing with almost any form of transportation. Should all downtown buildings be built on stilts to give room for driving and parking? What is sacred anymore about the first floor being on the street level now that we have escalators and moving sidewalks if we want them?

8 Highway Safety

There has been some improvement in the death record per passenger-mile, but we are still cutting a very bloody swath on the highways. Can the engineer contribute anything to the improvement? He can.

One approach is to improve design and construction of highways and streets. We've learned a lot about designing for safety, but there is much more to be learned. Experimental and statistical data indicate that about half the deaths on the highways could be eliminated, and an equal proportion of injuries alleviated if automobiles were designed with more of an eye to safety. Progress along this line has been inadequate. The automotive engineer should be prepared to give increased consideration to safety features in the design of tomorrow's car.

9 Fuel Supply

In America the use of gasoline has increased 250% in 12 years. Now the rest cf the world is becoming industrialized and its people are demanding more automobiles. What will happen to the liquid fuel supply within the next few decades?

It seems inevitable that tomorrow's automotive engineers are going to have to do some serious thinking and exploration into new sources of energy for the automobile. Will we begin duplicating nature and synthesize liquid fuels by photosynthesis? If so, the mechanical engineer who designs powerplants is going to have to join forces with the chemist, the biochemist, and the chemical engineer.

Central nuclear powerplants will be able to produce unlimited amounts of electrical energy and probably at very low costs. Can this electrical energy be applied in a practical manner to the propulsion of the private automobile? The amount of energy that can be stored per pound of battery is much too small. Is some new approach possible for the problem of storing electrical energy? This may be a fair question for the solid-state physicists, but I do not think they have seriously looked into the problem yet.

Perhaps there is a solution that will make it possible to store electrical energy by physical rather than electrochemical means, in the form of some solid package weighing 100–200 lb which would furnish the energy to drive a car 200 or 300 miles. That would open up a new era in automobile transportation.

Jet Engines Ask Still More

Based on paper by

E. A. Droegemueller and R. K. Nelson

Pratt & Whitney Aircraft, Division of United Aircraft Corp.

FOR modern turbine engines, it's necessary to control stability and burning characteristics of the fuel as well as the conventionally controlled properties, Pratt & Whitney Aircraft has found.

Thermal Stability

Thermal stability characterizes the fuel's ability to be used at high temperatures without forming carbonaceous deposits which interfere with its distribution and dispersion in the combustion chambers. This property is becoming important even in subsonic flight such as commercial transports.

The fuel receives heat on its trip through the engine from many sources such as pumping energy, fuel oil heat exchanger in some installations, and finally in the manifold prior to its release through the nozzles. The manifold and nozzle clusters are washed by very-high-temperature air delivered from the high pressure compressor, and the nozzle itself is very hot because of the radiant heat it receives from the flame in the burners. Therefore, the fuel is thermally stressed as it is used. Fuel with insufficient thermal stability can cause deposits to form in the fuel system, which in turn interferes with proper dispersion of the fuel through the nozzles. When this occurs, fuel is no longer evenly distributed through the several nozzles and the energy release in each combustor differs. The result is hot section damage caused by the uneven temperature pattern.

Development of a Thermal Stability Test

When fuel instability was found to be a problem, Pratt & Whitney Aircraft launched a comprehensive program to determine if control of fuel quality would solve it. After much work with full-scale rig equipment and full-scale engines, it was found that thermal stability was not to be controlled directly or indirectly by means of existing fuel specification requirements. Accordingly, the help and cooperation of some of the major fuel producers was obtained to investigate and develop a test which would be suitable for control of thermal stability. The test, as developed, was subsequently refined and out of it came the CFR fuel coker.

The effect of fuel quality (thermal stability) on engine performance was watched during the five-year developmental period. The evidence gathered showed fuel defined as unstable in the CFR fuel coker often to be responsible for excessive deposits in the engine fuel system, which led in many cases to early removal of engines or abnormal replacement of hot parts at time of overhaul. The severity of the trouble indicated by an engine is closely related to the severity of operating conditions. For this reason there never will be a perfect correlation between thermal stability (CFR fuel coker rating) and engine field experience.

This lack of correlation seems to bother some people, but it is analogous to the situation of a piston engine where the damage done by detonation is influenced by the operating conditions of the engine and is not always directly proportional to the fuel octane rating.

Burning Characteristics

During the actual combustion process it is vitally important for the fuel to release its stored energy completely (combustion efficiency), and do so without abusing the engine parts exposed to the high energy release section.

The combustion efficiency is controlled adequately by fuel volatility requirements, but the overheating of certain parts is the cause of much concern. Basically, this problem is associated with a function of the amount of carbon in the flame during the combustion process. Flames containing carbon burn luminously and add undesired heat by radiation to the adjacent parts. Combustion-chamber

# of Fuels

design can influence the extent of damage to some degree, but fuel composition which is not specifically controlled can influence greatly the amount of carbon formed in the flame, hence the amount of radiant heat produced.

Early experience with jet fuel (JP-3, JP-4) indicated the inadequacy of controlling the carbon-forming tendency of the fuel by smoke point alone. Therefore, a method of control was evolved which combined smoke point and volatility requirements into a smoke volatility index. The smoke volatility index was effective for the volatile JP-3 and JP-4 fuels, but when kerosenes were again used the SVI was ineffective because there was no "credit" for volatility and the expression essentially reverted back to the smoke point alone. The type of ingredients most offensive in carbon formation were aromatic materials and, in particular, the multiring aromatics. Proposals were made to limit the amount of aromatics boiling over 400 F to 5% max in an effort to control this property effectively, but the oil industry regarded this requirement as overly restrictive and unsatisfactory. The alternative was to specify a smoke point requirement sufficiently high to ensure adequate performance, realizing that certain adequate fuels thereby may be judged unsatisfactory.

Development of Suitable Test

In working on the problem of developing a method of defining the combustion property of a fuel, suitable for kerosene as well as JP-4 fuel, the engineers found that for the normal kerosene type hydrocarbons which would comprise the commercial jet fuel, the property could be controlled by limiting the multiring aromatic components as measured by an ultra-violet, spectro-photometry technique. Accordingly, this procedure was detailed and subsequently evolved into the Federal Test Method Standard 791 Method 3704T.

The Pratt & Whitney Aircraft fuel requirements sheet was revised to permit use of a fuel below the 25-mm smoke point minimum requirement, provided it had less than 3.0% by volume of naphthalenes as measured by the UV technique. This alternate test method gave the airlines more flexibility in dealing with fuel suppliers.

While testing on the instrumented full-scale, single-combustor test rig it was noted that a change in combustion liner temperature of up to 500 F could be obtained with the same total energy release in the burner by using extreme quality fuel. This was, therefore, a direct function of fuel quality. Moreover, fuels representing realistic candidates for commercial jets would encompass a range of up to 200 F. The control of 3.0% naphthalene was recognized as an adequate immediate fix, but it was also recognized to be unsuited for all advanced fuel requirements, since it is possible to fool the test by using certain types of hydrocarbons.

Search for a Better Test

Since a more basic test is needed, work is continuing. Out of cooperative work may come a test fundamental enough in nature to replace the several methods which have been used to control the carbon-forming tendencies of fuels. If that happens, one test, simple to operate (less than 1 hr per fuel and 2-oz sample) may replace the smoke point requirements, smoke volatility index requirements, and the naphthalene content.

Minimum Fuel Quality Requirements
(As established in PWA 522)

Volatility:	
Max Distillation Temperature, F	
10%	400
90%	500
Final Boiling Point	572
Max Reid Vapor Pressure, psi	3.0
Low-Temperature Characteristics:	
Freezing Point, F below min engine inlet temperature	10
Max Viscosity at −20 F, cs	10.0
Max Water Tolerance, ml	2.0
Compatibility with Other Materials:	
Max Sulfur Content, %	0.30
Max Copper Strip Corrosion	Slight discolor
Max Mercaptan Sulfur, %	0.005
Max Aromatic Content, %	20.0
Metering Characteristics:	
Gravity, deg API	37–57
Min Energy Content, Btu/lb	18,400
Stability:	
Max Existent Gum	7.0
Max Potential Gum	14.0
Max Thermal Stability at 300/400/6	
Filter ΔP 5 hr, in. of Hg	12.0
Preheater Deposits	Slight discolor
Burning Characteristics:	
Min Smoke Point,* mm	25.0
Min Smoke Volatility Index*	54.0
Max Naphthalene Content,* % (volume)	3.0

* Fuel must pass one of these requirements.

To Order Paper No. 47A . . .
. . . on which this article is based, turn to page 5.

strain aging

can be controlled on low-carbon sheet steels. Combination of chemical and mechanical means now in use. Prospects are bright for nonaging steels.

Based on paper by

E. R. Morgan

Jones & Laughlin Steel Corp.

IT HAS been demonstrated that all of the effects of aging low-carbon sheet steels can be eliminated by chemical mechanical controls—without the necessity of complete control by either.

Besides making available solutions to existing aging problems, this demonstration makes bright the prospect for new nonaging steels in the future.

The chemical means of preventing yield point return between temper-rolling at the steel plant and use by the customer consists of adjustment—by alloying additions—of the nitrogen in solution. The mechanical control consists of making the yield point by means of mechanical working.

Chemical control, if efficiently applied, can completely eliminate all aging effects. But mechanical control can mask only the yield-point effects; it cannot control loss of ductility. For deep-drawn parts, where ductility is important, therefore, chemical control must be applied. But in shallow-drawn parts, where only surface finish is important, mechanical control alone may be sufficient.

Since the process of strain aging seems to result from migration of carbon and nitrogen atoms, the combination of chemical and mechanical controls is aimed at:

a. Controlling the rate of migration.
b. Controlling the time available for migration.
c. Controlling the amounts of carbon and nitrogen which are free to migrate.

Refrigerating stocks of deep-drawing steels would decrease migration rates, but the cost would be exorbitant.

Another non-feasible way to make the strain aging problem disappear would be if the customer were to receive "as-annealed" coils and temper-roll or roller-level them to eliminate the yield point just before use.

The steel-maker can reduce the amount of carbon so efficiently by careful box-annealing that carbon is no longer a significant contributor to strain aging. But nitrogen is always a problem, because it's hard to precipitate enough nitrogen during processing. With all present steelmaking processes, the amount of nitrogen remaining in solution in box-annealed, rimmed steel is sufficient to result in significant aging within a short storage period.

But it can be successfully removed from solution by alloying with a strong nitride-forming element.

Vanadium and boron are two elements which will combine strongly with nitrogen, yet not result in a killed steel. (Aluminum, titanium, zirconium, and columbium result in a killed steel.) But both vanadium and boron have disadvantages, too. Vanadium-treated steel has to be very carefully processed to guarantee nonaging properties. Boron has a moderately strong affinity for dissolved oxygen in the steel, which leads to steelmaking problems.

Within the chemical control classification, attempts are being made to improve the surface of aluminum-killed steels, which are at present the generally available source of nonaging steel. One approach to this problem is to pour a partially killed steel into a mold which contains a suspended bar of aluminum. The aluminum melts readily and kills the steel, and there is less tendency for it to produce surface defects. An alternative approach is to push a bar of aluminum into the middle of a mold which has just been filled with rimming steel. This, too, results in improved surface quality.

The use of vanadium has been stimulated by the realization that it can be used more efficiently by means of mold additions. Studies of the aging

characteristics of vanadium-treated steels have shown that carefully controlled annealing can produce a nonaging steel.

Boron additions have been successful in producing rimmed and capped nonaging steels, but the affinity of boron for oxygen means that special addition techniques must be used. Boron has also been used to produce nonaging semi-killed steels. In this case, the problem is chiefly that of controlling the oxygen content of the steel so as to obtain a good structure. A rapid oxygen analysis test has been developed for this purpose, but progress has been retarded by lack of a good oxygen sampling procedure.

Vanadium and boron-treated nonaging steels have been and are being used on a limited scale but require further development. Even when these elements are not completely successful in eliminating aging, they may so restrict the degree of aging that loss of ductility does not occur during prolonged storage, even though the yield point reappears.

This degree of control would be sufficient if such steelmaking practices can be combined with mechanical control developed to the point where prolonged aging did not restore the yield point. Now that it has been established that masking of the yield point is most effective in those steels which possess high residual stress patterns, it has been possible to plan detailed examination of the mechanical factors which give rise to such patterns.

It has already been determined that such factors as roll size, roll roughness, and sheet grain size are of importance. Many other commercial factors such as the effect of initial shape and the amount of tension during temper rolling have not been adequately examined. The necessary experimental work on commercial rolling mills is now being undertaken.

Now that it has been demonstrated that all of the effects of aging can be eliminated by combined chemical and mechanical control without the necessity for complete control by either, there are good prospects that new nonaging steels can be produced in the future.

The steel industry clearly has progressed toward the solution of this strain aging problem, which has long plagued users of low-carbon sheet steel.

To Order Paper No. 30A . . .
. . . on which this article is based, turn to page 5.

Ameripol SN . . .

. . . can replace natural rubber in tires. Tests prove it to be comparable to Hevea rubber in most respects.

Based on paper by

W. L. Semon and M. A. Reinhart

B. F. Goodrich Co.

AMERIPOL SN can be used satisfactorily in tires as a replacement for natural rubber, recently completed tests prove. As a result, private industry—well aware of the importance of having a domestic source for such a rubber—is proceeding actively to develop a commercial process for its manufacture.

To evaluate the product, tests were run with 11.00×20, heavy-duty truck and bus tires in which all rubber in tread and carcass had been replaced with Ameripol SN. The results were as follows:

Indoor Wheel Test—This is a very severe accelerated test in which tires are run to destruction. They are run on smooth 67-in. diameter wheels in an ambient temperature of 100 ± 5 F at a speed of 50 mph. The test is continuous with the load increased in increments amounting to 20% of the rated load capacity each 24 hr. The test is started at 80% of standard Tire and Rim Association load.

The heat buildup in Ameripol SN, Type A, tires was slightly less than that in the Hevea rubber control tires, and the mileages run were comparable. Resistance to growth was better than in the control tires (an average of 12% increase in cut growth in contrast to 26% for Hevea control tires).

Test Truck Operation—This accelerated service test is less severe than the indoor wheel test. The trucks are run on a 24-hr-per-day basis at 45 mph. Tires are rotated to the four wheel positions at 700-mile intervals. Loads, speeds, and inflation pressures are closely controlled. The test is run at standard Tire and Rim Association load for 2800 miles, followed by 2800 miles at 130% rated load, then run to failure or completion of 19,600 miles (whichever occurs first) at 150% rated load.

Resistance to growth of initiated tread cuts was good—comparable to controls. Independent cracking of Ameripol SN was slightly inferior. All carcasses were sound after 19,600 miles. They were recapped and placed in intracity bus operation.

Mileage Contract Bus Operation—This is a rigorous intercity operation where speeds may exceed 70 mph. Loads naturally vary. The front wheel positions are usually overloaded (say, up to 130%) while the rear are reasonably close to rated loads. It is customary to place new tires on the front, run them 15,000–25,000 miles, then switch them to the rear, in order to get optimum service and maximum safety.

Ameripol SN, Type A, tires varied in mileage because run on different vehicles, but a particular lot of 10 placed in high-speed, intercity bus service were all sound after accumulating 600,000 miles of travel to the time of regrooving of the treads. While independent tread cracking is slightly inferior to control tires, the severity is not alarming.

To Order Paper No. 28A . . .
. . . on which this article is based, turn to page 5.

Curing Car Shake by New Lab Method

Based on paper by

Kenneth P. Pettibone

Ford Motor Co.

FORD has developed a method for simulating car shake in the laboratory which permits close observation and amplitude measurements along the length of a vehicle, using available laboratory equipment.

Tortional shake is produced by having the front or rear wheels supported on and excited by a transverse beam pivoted at the longitudinal centerline of the car. The wheels at the end of the vehicle opposite the "shake rig" are supported on wheel blocks. To excite the vibration, an electromagnetic vibrator is attached to the transverse beam outboard of the vehicle (Fig. 1).

The force applied to the beam by the vibrator is monitored by a load transducer and a direct inking oscillograph. After an arbitrary force is selected which can be maintained through the range of shake frequencies (about 10 to 20 cps), the natural frequencies of the various modes of torsional shake can be obtained. This is done by applying the constant maximum exciting force and measuring the shake amplitudes at the locations checked on the road at 0.5-cps increments of frequency. The frequency at which the amplitudes of shake are a maximum is considered to be the natural frequency for that mode.

Symmetrical or bending shake is produced by supporting the vehicle on wheel stands and locating the vibrator centrally at the front, center, or rear of the chassis (Fig. 2). A constant maximum force is applied to the frame at one of the above locations by an electromagnetic vibrator. Amplitudes at the various locations on the car are measured at 0.5-cps increments of frequency through the shake range. As with torsion, the natural frequency of the various bending modes is indicated by maximum shake amplitudes.

How the Method Is Applied

To illustrate how a shake problem can be investigated in the laboratory, let us assume that we have a vehicle with an objectionable front-end sheet-metal shake to be identified and cured.

The first step is to determine the mode and frequency of the shake on the road, together with the frequency of wheel movement. The car is then brought into the laboratory and the structure is vibrated in the mode and frequency of the shake occurring on the road. The masses vibrating (front-end sheet metal, engine, and front end of the frame) are noted as well as the part of the structure acting as the "spring," which might have to be detuned. To find the "spring," the shake amplitudes of the

Fig. 1—Torsional vibration setup used by Ford to simulate road shake in the laboratory.

Fig. 2—Bending shake is produced with this setup at Ford. Vibrator is located centrally at front, center, or rear of chassis.

6-STEP PROCEDURE TO SOLVE CAR SHAKE PROBLEM

1. Determine the mode and frequency of the objectionable shake on the road and the frequency of front and rear wheel movement.

2. Reproduce the same mode of shake in the laboratory and determine its natural frequency.

3. Note the principal masses of the vehicle that are vibrating and determine the part of the structure which, by its distortion, is acting as the "spring" of the vibrating system.

4. First vary the effective mass (make changes in engine mounts), then change the "spring" rate to detune the natural frequency of the structure as far as possible from the wheel frequencies.

5. Try isolation and absorption if necessary.

6. Evaluate reduction in car shake by observation ratings and amplitude measurements made on the road.

fenders, hood, radiator support, frame cross-members, and side rails are checked.

If the front-end sheet-metal shake is greater than that of the frame side rails, there is a possibility of changing the rigidity of the offending part of the structure between the frame and fenders, such as the hood lock plate. Should the sheet metal and frame be in phase and have the same amplitude, the amplitudes of the side rails and sheet metal are obtained along the structure and plotted to determine the area acting as the "spring." The natural frequency of the particular mode involved is obtained and compared with the frequency of the shake occurring on the road and the suspension frequencies. Generally, if objectionable shake occurs on the road, the natural frequency found in the laboratory either corresponds exactly or is very close to the frequency occurring on the road. Therefore, knowing the vibrating masses and the "spring," exploration is made of the principle that natural frequency varies directly with the square root of the spring rate or stiffness of the deflecting structure and inversely with the square root of the mass.

Significance of Engine Mounts

Since the engine represents a large percentage of the vibrating masses, varying its mounts is investigated in an effort to detune the natural frequency of front-end shake. By using mounts with a high vertical rate, the engine mass can be made to move with the frame, while with low-rate mounts the engine can be isolated from the frame or actually made to move out of phase with the frame. The high vertical rate then increases the effective vibrating mass, whereas the low rate reduces the effective mass.

Substantial changes in natural frequency and front-end sheet-metal shake have been produced by changes in engine mounts (Fig. 3). Engine mounts having different rates are installed to determine the lowest vertical rate resulting in the desired change in natural frequency. Other characteristics

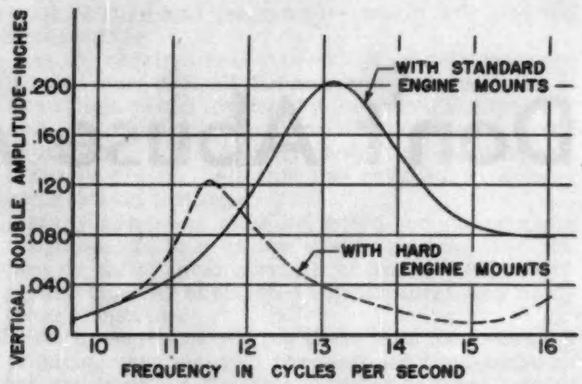

Fig. 3—Changes in engine mounts can produce substantial changes in natural frequency and front-end sheet-metal shake. Mounts with high vertical rates usually give least front-end shake, but sound and harshness may become objectionable if rates are too high.

such as noise and harshness are affected by engine mounts so that compromise is generally necessary. Since mounts having high vertical rates usually result in the least front-end shake, an evaluation should be made to determine how high the rate can be without the sound and harshness becoming objectionable.

Effect of Reinforcing Structure

If sufficient detuning and shake reduction are not accomplished by changing engine mounts, a survey of the structure is made to determine an area of possible local weakness. With the car vibrating at the frequency of road shake, amplitude measurements are taken along the structure at 10-in. stations and a deflection curve is plotted similar to the usual static deflection curves. If it is assumed that the natural frequency of the front end shake is found to be higher than the frequency of the disturbing road shake, the area indicating a weakness can be reinforced both to detune the frequencies still further and quiet the shake due to the increased rigidity. However, if the natural frequency of the structure is below that of the road shake, reinforcing the structure tends to make the two frequencies coincide and, in spite of the increase in rigidity, the shake amplitudes may tend to increase.

Some cars have natural frequencies of both torsion and bending in the frequency of wheel movement on the road. In most of these instances the torsional mode occurred more frequently on the road. Comparison of two cars revealed one having objectionable center of car lateral shake, while the other was acceptable. The acceptable car had the natural frequency of torsion above the range of wheel frequencies, while the objectionable car had it directly in the range. Both cars had the natural frequency of bending in the range of wheel frequencies. In other words, the torsional mode may be excited more frequently on the road, probably as a result of road irregularities being unsymmetrical for right and left wheels. Detuning the natural frequency of torsional shake from the suspension frequencies may be more important than detuning the bending frequencies.

To Order Paper No. 25B . . .
. . . on which this article is based, turn to page 5.

Don't Abuse Adhesives

Design joints for their use. See that the adhesives are properly applied and cured.

Based on paper by

F. J. Wehmer

Minnesota Mining and Mfg. Co.

GETTING maximum performance from adhesives requires that the adhesives be properly used. Joints must be correctly designed for the adhesives and the adhesives must be properly applied and cured.

In considering the use of adhesives in various joints, we should remember that almost all adhesives provide greater strength in shear than in direct tensile or in peel. By designing a joint correctly, it is possible to take advantage of the good properties of adhesives and to minimize the effect of their weaknesses.

Fig. 1 shows the manner in which stresses may be applied to an adhesive bond. Fig. 1a indicates a force being applied in pure tension. When a load is applied perpendicular to the plane of the joint, all of the adhesive is placed under stress. These stresses are easy to calculate and adhesives give a good account of themselves in this type of application.

Fig. 1b indicates a bond loaded in shear. Here the stresses are parallel to the joint and again all the adhesive is under stress at the same time. Adhesives used in this manner probably provide the maximum effectiveness and joints should be designed to take advantage of this fact wherever possible.

Fig. 1c indicates a bond being stressed under cleavage. Here there is a concentration of forces at one side of the bond, while the other side carries very little or none of the load. It is difficult to calculate the stresses in a joint of this type and wherever possible adhesives should not be used where they will be subjected to this type of stress.

Fig. 1d shows a bond being stressed in peel. In many respects peel and cleavage are alike, the difference being that peel requires at least one of the stressed members to be flexible. When a bond is pulled apart by peeling all of the stress is concentrated along a line. This makes a very small portion of the adhesive carry all of the load and joints

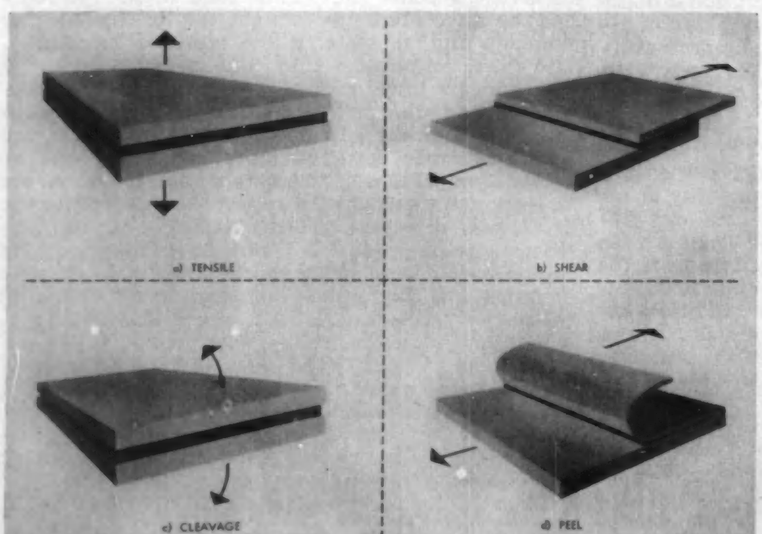

Fig. 1 — Basic types of adhesive joint stress.

should be designed to avoid stressing in peel.

Joints usually are subjected to a combination of the various types of stresses just mentioned. Since most adherends are not completely rigid, deformation causes combinations of stresses to be introduced. Fig. 2 shows how materials deform under shear loading.

The elastic material necks down and cleavage forces appear at the edges. If the deformation goes far enough, peel may occur. Obviously then, the adhesive is not being used only in shear.

Even where rigid materials are used, we do not get shear only. This is illustrated by Fig. 3, where under moderate load there is an indication that the stress is not all shear. At extreme loads, it is apparent that stresses other than shear are acting on the bond.

By now it must be apparent that no one adhesive is going to satisfy all applications. There is, however, a wide variety of adhesives available for use. They range all the way from very soft and extensible to very hard and brittle ones. They also range from those with very little resistance to elevated temperatures to those which will withstand temperatures of 450 F.

Adhesives are available in a number of forms. They may be dispersed in a liquid medium. They may be in the form of 100% solids liquids, pastes, or films. In any event, the surfaces to be adhered must be wet by the adhesive being used. In the case of the dispersed adhesives this normally takes place when the adhesive is applied. If the dispersing medium can escape, the adhesive gains in strength and becomes strong enough to do the job expected of it.

In the case of 100% solids liquid materials, they also wet the surfaces in application but must then gain strength by the cross-linking of the polymer by means of activators. With film adhesives this activation is usually accompanied by heat and pressure since the activator is already in the film. The heat also liquefies the adhesive enough to cause it to wet the surfaces being bonded.

It is necessary to see that enough adhesive is applied, that it is properly dried or cured, and that the adherends are brought into complete contact with the adhesive, otherwise a bond which is only partly effective will result.

Liquid adhesives can be applied in a number of ways. A great deal of adhesive is still applied by brushing, but more and more adhesives are being sprayed. Dipping is sometimes used, and roll coating is becoming more popular as a means of applying adhesives.

To obtain the maximum value from an adhesive, it should be used so that it may give that value. Dispersed adhesives must have an opportunity to lose the dispersing medium, since any that is retained in the bond will act as a plasticizing agent and will reduce bond strength.

Those adhesives which require heat, or heat and pressure, will only give a good account of themselves if they are applied to properly cleaned surfaces. In fact, any adhesive will do a poor job if applied to a surface which is not clean, since it will adhere to the soil which in most cases has no adhesion to the adherend. Surfaces should also be dry since moisture or oil will also prevent adhesion.

Curing adhesives should be cured at those conditions of time and temperature which will give the best results.

As the requirements expected of an adhesive have become more difficult, it has become necessary to do more work on the testing of adhesives. The military and industrial specifications are constantly being expanded as is the activity of various scientific and industry groups. All this has resulted in greater emphasis on testing.

Many adhesives must be tested for temperature resistance, fatigue at low and high temperatures, peel strength, shear strength at low and high temperatures, creep at elevated temperatures, and many other properties.

The necessity of making these tests has become a problem, since many of the tests are time-consuming and lengthen the time required between receipt of an order and the time at which it can be shipped. In addition, many of the modern adhesives are perishable and therefore cannot tolerate excessive delay.

It would be simple to answer many of the questions which are posed by the problems of testing if it were possible to nondestructively test adhesive bonds. Much work has been done on nondestructive testing and this work will, no doubt, continue. It has been possible to predict some of the properties of bonded areas by using ultrasonic devices and these methods will definitely pick up unbonded areas. Even this is an advance since adhesives perform best if the entire area is well bonded.

To Order Paper No. 34A . . .
. . . on which this article is based, turn to page 5.

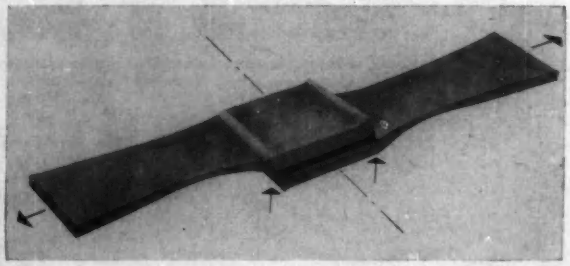

Fig. 2 — Deformation of elastic material under shear loading.

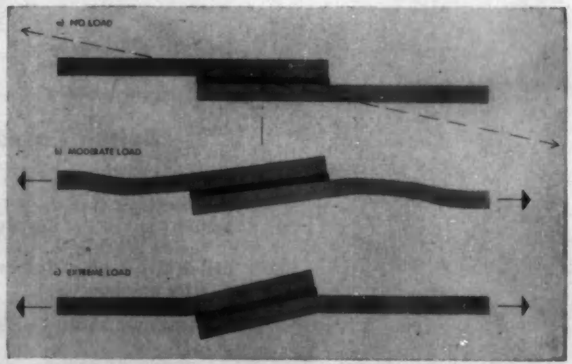

Fig. 3 — Reorientation of shear bond under conditions of increasing load.

TREADWEAR LIFE

Surveys of new cars in 1953 and again in 1956 showed that
provements in tires — lost 18% in his treadwear expectancy during
Improvements in car design in recent years have affected
with respect to treadwear. Increased acceleration, more efficient
and ability to corner more rapidly have all resulted in a marked
These tables show the effect of the newer cars on treadwear.

Based on paper by

T. A. Riehl

Goodyear Tire & Rubber Co.

Effect of Braking and Acceleration on Treadwear

Same Size 14 in. Tires Used Throughout; 50 mph Maximum Speed

	Treadwear Rating
Continuous Driving	100
Control Stop Every 5 Miles	51

Effect of Groove Shrinkage on Cracking

Groove Shrinkage From Molded Dimension	Miles to Start Cracking	
	100 mph Road Test	Laboratory Dynamometer
0	300	9000
20%	175	5300
30%	100	1900

Effect of Car on Treadwear

Same Size 14 in. Tires Used throughout; 50 mph Maximum Speed

Car Year of Manufacture	Treadwear Rating	
	Fronts	Rears
1953	100	100
1955	85	75
1957	80	60

Belted Passenger Tire Treadwar

	Treadwear Rating
Conventional Tire	100
Belted Tire—Radial Carcass—Textile Breaker	145
Belted Tire—Radial Carcass—Wire Breaker	185

down 18%

the average motorist — despite known im-
this period.
adversely ultimate tire life, particularly
braking, sustained higher-speed driving,
increase in the rate of treadwear.

Effect of Speed on Groove Cracking

Passenger Tires

Speed, mph	Miles to Develop Cracking
60	7000
80	1000
100	100

Effect of Tensile Retention on Treadwear

	Tread Stock A	Tread Stock B
Original Tensile	2,780	2,700
Aged Tensile*	1,825	2,160
% Tensile Loss	34%	20%
Treadwear Rating	100	108

* Aged 7 hr at 80 psi and 236 F.

Treadwear of Polyurethane Rubber

Type of Rubber	Treadwear Rating
Present Tread Stock (SBR Rubber)	100
Polyurethane Tread	192

Effect of Speed on Treadwear

Passenger Tires

Rate of Speed	Mileage to Smooth	Treadwear Rating
65–70 mph	16,630	100
85 mph	8,955	54

Effect of Speed on Treadwear

Passenger Tires

Speed	Treadwear Rating
50 MPH	100
60 MPH	79
70 MPH	63
80 MPH	43

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. . . on which this article is based, turn to page 5.

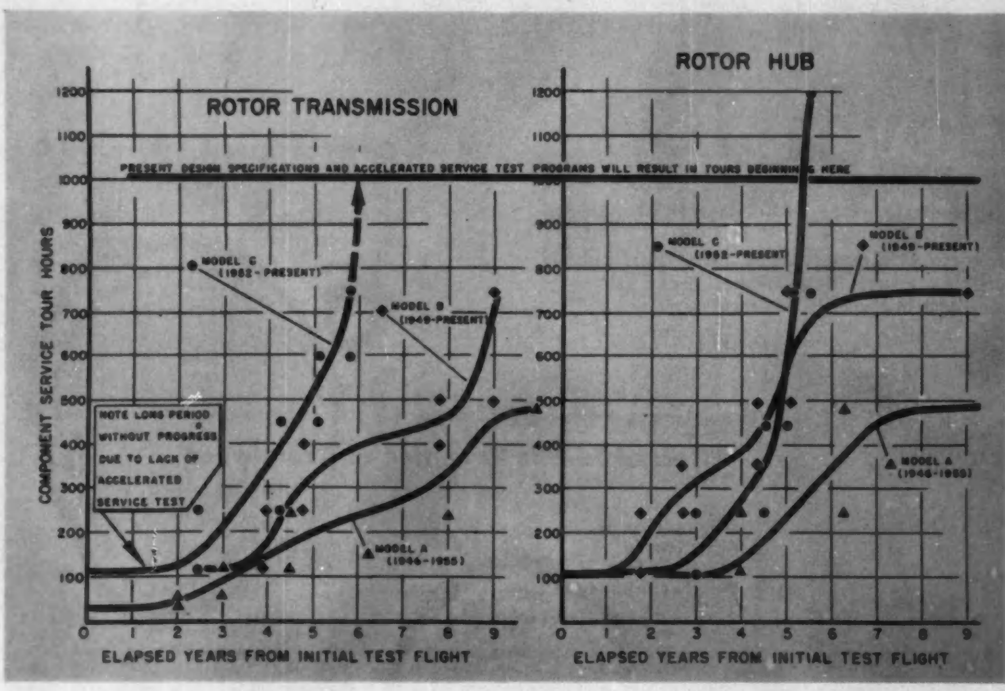


Fig. 1 — Progress made in extending major component overhaul periods on three models of Vertol helicopters.

Helicopter Service Costs

Based on paper by

T. R. Pierpoint and R. S. Leslie

Vertol Aircraft Corp.

SERVICEABILITY of helicopters is the competitive yardstick of 1958. Increased payload performance and military experience opened the way to high tour life of parts and exacting control of maintenance. New designs are now starting with a 1000-hr part overhaul interval.

Here are outstanding problems in the seven primary areas of maintenance and serviceability and what has been done to solve them:

Analytical Design Aspects

Problems — The primary goal has been to provide long-life, trouble-free major components. The principal problems have been:

1. To develop bearings capable of taking high stresses while oscillating over a small radial arc. This type of loading is most typical in rotor hub assemblies but also occurs to some degree in control components.
2. To develop all-metal or metal and plastic rotor blades without a finite fatigue life.
3. Development of rotor transmission gearing.
4. Substantial reduction in helicopter vibration, which will bring about a contingent increase in the life of both static and dynamic structures.
5. To develop a suitable clutch and overriding devices. Advances have been made. Small gas turbine engines of the free-spool type will eliminate the clutch and make necessary only some type of overriding feature.

Solutions — Progress made in this area is graphically illustrated by Fig. 1 which indicates the improvements made in major component overhaul periods on three Vertol models. Model C did not reach its present tours until more than five years after its initial test flights. The military services and all manufacturers undertaking new designs now require components to meet 1000-hr overhaul periods initially and, since this has been achieved, we can expect 1500- to 2000-hr components by about 1965.

Moreover, the industry has been endeavoring to eliminate all parts having a finite service life, and it has made progress.

Detailed Design Aspects

Problems — The objective is to make helicopters easy to inspect and easy to repair when defects are

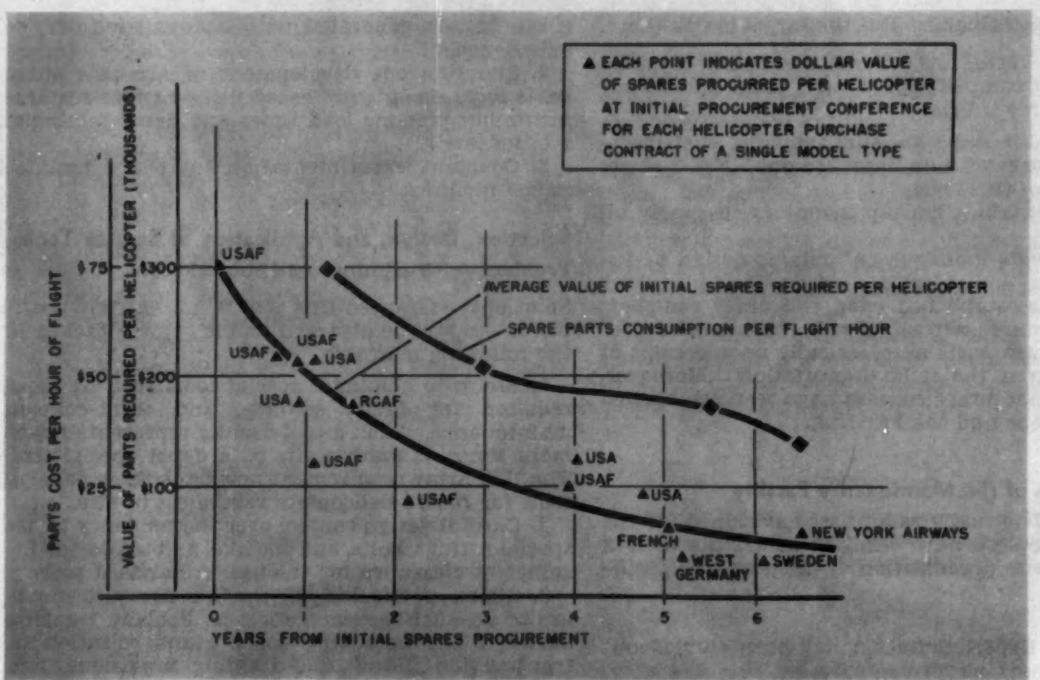


Fig. 2 — Success in redesigning parts to reduce spare parts usage is shown by actual records of the H-21 (Vertol 44) helicopter. Important point is the difference in the slopes of the two curves rather than decrease in both.

Tumbling

noted. Progress in detailed design has resulted mainly from the design engineer's increased appreciation of the mechanic's daily task.

Solutions — A few of the detailed design items which have resulted in maintenance and serviceability improvements not in wide use on pre-1954 models are:

1. Generous use of integral work stands and steps.
2. Self-closing magnetic sump plugs.
3. Visual fluid level gages.
4. Cable quick-disconnects.
5. Packaged components (quick-engine-change kits plus combination rotor transmission, control, and hub assemblies).
6. Standardized fluid quick-disconnects.
7. Simplified control rigging and adjustments.
8. Plug-in type test connections and outlets.
9. Quick-change mounting of minor accessories and units.

Training and Skill Level Appraisal

Problems — Experience in Korea made evident that very highly trained experts were not always required for maintenance, but that the training then available placed too much emphasis in some areas and not enough in others.

Solutions — As a result of Korea the industry was able to accomplish the following:

1. Accept a lower standard of mechanical capability in some phases of maintenance.

2. More clearly define the types of training most necessary.

3. Develop much improved training aids.

4. Develop course curricula to a point where the mechanic can select any of a number of branch specialties.

5. Integrate training into major programs by such aspects as development and continuation of extensive factory schools, adoption of mobile schools, and active on-the-job training.

Spare Parts Selection and Distribution

Problems — Much as the industry would like to produce a machine requiring no spare parts, this is

obviously unattainable. But the target is still there.

Solutions — Vertol has followed the policy of maintaining most complete spare parts usage data to accomplish three things:

a. To enable redesign and supplant the excessively used part with an improved one. Fig. 2 shows the success of this policy.

b. To maintain a backup inventory to supply all customers.

c. To provide guidance on systems design of future models.

Vertol has established open end order contracts wherein a sum is deposited with the manufacturer who then ships parts automatically upon receipt of an order from the field organization. Moreover, prime manufacturer licensees have been established in both Europe and the Far East.

Organization of the Maintenance Facility

Problem — The vastly wider uses envisioned for the larger helicopters have resulted in a state of flux with respect to organization of maintenance facilities.

Solutions — Experimentation has been carried out on a wide front, as for example:

1. Accurate determination of present requirements and projection of future requirements predicated on improved design and the usual learning curve factors generated with accumulated service experience.
2. Simultaneous development of accurate spare parts requirements not based just on usage requirements but pipeline lead times and depot minimum reorder levels.
3. Constant experimentation to reduce maintenance facilities.

Selection, Design, and Application of Service Tools

Problem — To eliminate all special tools.

Solutions — Granted this goal is not entirely possible, it can still be attacked and is being attacked in the following manner:

1. Strive to eliminate special tools such as those required for first-, second-, and third-echelon maintenance. Such a tool usually represents 100 or more times as many units as a depot special tool. The U.S. Army requirement now bans these echelon tools for future helicopters regardless of size.
2. Careful design control over the tendency to use special fittings, bolts, and the like, and to provide insufficient clearance for the use of standard tools.
3. Efforts, particularly by the U. S. Army, to standardize on such common tools as a blade tracking device, blade balancing tools, standardization of transmission filling and draining provisions, and hoisting davits.

To Order Paper No. 37C . . .
. . . on which this article is based, turn to page 5.

Turbojet Pilots . . .

. . . need range capability system to answer question, "Do I have enough fuel to carry out mission and to get back?"

By Floyd A. Andrews

Aeronautical Division, Minneapolis-Honeywell Regulator Co.

ONE of the questions continually facing the crew in a modern turbojet interceptor is, "Do I have enough fuel to make the intercept and return to my home base or an alternate base?" The aircraft's range capability in relation to that required to complete the mission must be continually monitored.

Recent studies and development projects at Minneapolis-Honeywell have attempted to answer this question.

The problem is particularly acute for interceptor crews since the nature of the mission makes detailed preflight planning impossible. Further complicating factors are:

1. The increasing work load of the crew.
2. Increased aircraft speed, fuel load, and rate of fuel consumption.

In addition, bulky gloves and pressure suits are not well adapted to the use of hand computers, even when cockpit visibility permits.

The delegation of the range capability problem to ground control intercept (GCI) centers is not the answer, since they cannot provide the crew with a continuous solution to the tactical range problem. Loss of communications, due to equipment failures in the aircraft or on the ground, or lack of time on the part of GCI personnel during saturation raids would result in a failure to get any range capability information to the crew. The SAGE network will not be concerned with the calculation and transmission of range data to the crew.

An obvious solution is to provide an airborne range computer with a suitable display. The particular computer design and data display can best be established by making an analysis of all mission profiles, a comprehensive crew work load study, and a study of the ground and air environment by system and human engineers. An analysis of this type will dictate the most useful computer and display configuration. In general, it has been found that an integrated display of the following data is desirable for an interceptor.

1. Present distance from selected base—obtained from the navigation computer.

2. Present range capabilities in the direction of the selected base, considering the effect of winds.

3. Tactical fuel reserve—the fuel quantity in excess of that necessary to complete the mission.

A typical computer to provide this intelligence would have input signals of remaining fuel quantity, true airspeed, expendable stores, and pressure altitude, as well as means for setting in airframe net weight (if a variable) and the desired fuel reserve. Any additional data peculiar to the mission would be stored as required. In calculating item No. 2, it has been found that the no-wind range (R) of a Mach limited aircraft flying at optimum altitude and optimum Mach number can be closely approximated by a modified form of the Breguet range equation:

$$R = (W_1 \times \mathrm{SR})_{max} \log(W_1/W_2)$$

Where:

W_1 = Initial cruise weight
W_2 = Final cruise weight
SR = Specific range
$(W_1 \times \mathrm{SR})_{max}$ = A constant for this type of flight path

Provision must be made in the computer for correcting the basic range computation for the effect of winds. This can be done by several methods which differ in complexity and accuracy. The basic problem, however, involves the determination of the component of wind velocity along any course, multiplying this component by the calculated time of flight, and adding the quantity so obtained to the no-wind range. If important, correction can also be made for ascent, descent and the range equivalent of aircraft kinetic energy.

The weight and accuracy of suitable airborne analog range computers are dependent on the complexity of the computation and the nature of the input signals. The computer weight might range from 6.0 to 12.0 lb and the accuracy from 1 to 3%, depending on the particular system.

Reference

"Cruise Control Instrumentation for Turbojet Aircraft," by H. W. Kidder. Paper presented at SAE National Aeronautic Meeting, New York, April 4, 1957.

Russian TU-114 Turboprop Transport . . .

. . . comes in three versions: 170-passenger cross-country, 120-passenger intercontinental, and 220-passenger short-to-medium haul.

Report to SAE Aircraft Activity Committee by

Secor Browne, W. H. Nichols Co.

THE 170-passenger version is designed for runs such as Moscow-Irkutsk (southwest of Lake Baikal) or Moscow-Delhi. "General commercial load" is 30 tons, according to an article in "Grazhdanskaya Aviatsia" for December 1957, which describes the new transport.

The 120-passenger version is said to be able to fly from Moscow to Vladivostok, Peking, or New York non-stop. The 220-passenger version is for runs like Moscow to Simferopol (Crimea); costs are claimed to be as low as for rail transportation.

The Tu-114 has a two-level fuselage — an upper level of passenger compartments and a lower level affording two baggage compartments and a kitchen.

Forward in the cockpit is the navigator's seat. Behind him and slightly higher are the pilots' seats. Behind these are the flight engineer's and radio operator's stations. Space is provided also for an additional navigator who will be taken aboard in flights over non-Russian territory.

Aft of the cockpit are the forward vestibule and two lavatories.

Forward passenger compartment seats either 41 or 53, depending on the version of the airplane. Second compartment provides for food service. In the 170- and 120-passenger versions there are eight tables, each seating six people. The 220-passenger version omits most of the tables and seats 66 in this area.

Behind the second compartment is a food-service section connected with the kitchen below by stairs and a dumbwaiter.

Next in all three versions come four small compartments each providing either six seats or three berths on two divans and a folding upper berth.

The aft passenger compartment seats 54, 28, or 76 passengers, depending on the version. In the tail are the vestibule, a large wardrobe, and two more lavatories. In both front and rear vestibules, doors are on the left side.

Cabins are pressurized to 8000 ft up to altitudes of 36,000–39,000 ft. Under the most rapid ascent or descent, cabin pressure changes at a rate equivalent to 6½ fps. Temperature is automatically held within 65–75 F. Ventilation system provides enough air flow to change cabin air 24–25 times per hr. Bulkhead between the cockpit and the forward vestibule apparently is intended to maintain pressurization for the crew even if pressurization is lost elsewhere.

Each of the four Kuznetsov turboprop engines has two four-blade contrarotating propellers. The Tu-114 can take off on three engines and can maintain flight on any two engines. Landing gear of the Tu-114 features four-wheel undercarriages and is similar in other respects also to that of the Tu-104.

(These paragraphs constitute an addition to the main body of Mr. Browne's report, which appears in two installments on pages 53–56 of the April and pages 26–29 of the May issues of SAE Journal.)

Europe Expands Steel-Making

Based on paper by

D. L. McBride

United States Steel Corp.

ALL countries in Western Europe are expanding their capacities for manufacturing iron and steel by installing facilities for beneficiating their local ores, importing better grade ores from Canada, South America, and Africa, and installing modern equipment and new processes particularly suited to solve the problems of steel production peculiar to the European area.

Western Europe is well on the way to doubling its prewar steelmaking capacity by 1960, at which time its steelmaking capacity will be about 122 million net tons annually. From the time of World War II when the United States accounted for about half the world's production of steel ingots and castings, the position of the United States has declined steadily until in 1957 this country produced only 35% of the world's steel. Except for three years immediately following the war, Western Europe has consistently produced about 26 to 32% of the steel produced in the world. If Russia continues to expand its steelmaking capacity at the same pace as maintained since 1944, within a few years the Soviets will be in position to challenge the leadership of the United States as the dominant steel producing nation.

Just as in the United States, in Europe there is an awareness of the value of beneficiated iron ores; existing iron and steelmaking furnaces have been enlarged; auxiliary facilities provided to improve materials handling; changes have been made in the type of refractories used for construction of furnaces; and improvements in combustion practice are evident. In addition, virtually every integrated steel works in Western Europe has installed facilities for producing high purity oxygen in large quantities at relatively low cost.

Because of the demand for peak production of steel in Russia and the need for lower nitrogen steels for flat rolled products in Western Europe, steelmakers in these areas are probably farther advanced than steelmakers in the United States in the wide-scale use of oxygen.

The low-shaft blast furnace can use European coal. The basic idea of the low shaft is the simultaneous carbonization of high volatile, noncoking bituminous coal and the reduction of briquettes made of a mixture of the coal iron ore fines, and fluxes. A conventional high-shaft blast furnace needs a coke plant, a sintering plant for agglomerating ore fines, and a gas cleaning plant. The experimental low-shaft furnaces are all relatively small, being capable of making only 20–80 tons of pig iron per day.

Maximum capacity for a low-shaft blast furnace has not yet been established and until this is determined the future of the low-shaft furnace will remain in doubt. A furnace at Troisdorf is expected to produce about 110–130 net tons per day of pig iron when using briquettes prepared from the fine, low grade minette ores of the noncoking, high volatile coal. In contrast, a high-shaft furnace of the same hearth area could produce 300–350 net tons per day.

Electric Smelting Furnaces

Electric smelting furnaces have been operated in Norway, Sweden, Italy, and South America. Although 10,000 kw furnaces capable of producing about 110–120 net tons per day of pig iron are fairly common in Sweden, the largest installation known is a plant in Norway with three 18,000 kw furnaces which should produce about 600–650 tons per day or less than half as much as one large, modern blast furnace.

Many European iron ores contain roughly 10 times more phosphorus than the North American ores, and pig irons smelted from these ores will contain 1.5 to 2.0% phosphorus. Of necessity, much of the European steelmaking capacity had to be designed to produce acceptably low phosphorus steels from high phosphorus pig irons.

Pig iron produced from high phosphorus iron ores can not be used in the Bessemer process. For treatment of this type of iron, Thomas in 1879 patented a pneumatic process in which the lining of the converter is constructed of basic refractories rather than the acid, or silica, refractories normally used in Bessemer converters; and lime or limestone are added as slag-making materials. Other than the differences in the type of lining and the addition of lime as a slag-making material, there are no marked differences between Thomas steel plants and Bessemer steel plants. Today, this process accounts for about half of the total steel produced in Western Europe.

Although phosphorus and sulfur are removed in the Thomas process, nitrogen content of the bottom-

Capacity

blown basic pneumatic steels is substantially higher than that for basic open hearth steels.

Use of an oxygen enriched blast, in addition to its influence on the nitrogen content of the steel, leads to a substantial increase in the scrap melting capacity of the Thomas converter. This aspect of oxygen enrichment has great significance since it permits expansion of gross steelmaking capacity without adding new pig iron and coke oven facilities. At present, 15–20 million tons annually, or about one-half of the Thomas steel produced in Western Europe, is being blown with an oxygen enriched blast. Significantly, all of the eleven Thomas steel plants in Western Germany are using an oxygen enriched blast.

The conventional air blast, with its objectionable nitrogen content, can be replaced completely by a properly balanced steam-oxygen blast or a CO_2-oxygen blast. With nitrogen completely eliminated from the blast, the nitrogen content of Thomas steel should be no higher than that of basic open hearth steels.

An important advantage of the steam-oxygen process is that superheated steam is readily available in every steel plant and the cost of generating steam is considerably lower than the cost of producing either carbon dioxide or high purity oxygen.

During the past five years, world-wide attention has been focused on the top-blown oxygen steelmaking method, first put into commercial operation in late 1952 at the steel plants at Linz and Donawitz, Austria.

During recent years, the Domnarvet Steel Works of the Stora Kopparbergs Berslags A/B, Sweden, has carried out research and development work and pilot plant trials on an oxygen process using a tilted, rotating vessel, in which the oxygen is introduced into the atmosphere above the bath rather than directly into the metal such as occurs in bottom-blown vessels, or in the top-blown oxygen process. The process is known as the Kaldo Rotary Oxygen Steelmaking Process and since May 1956, has been operated on a pilot plant scale using a 30-ton vessel.

In January 1957, it was announced that the Kaldo process will be used as the basis for a new modern steel plant at Oxelosund, Sweden. This plant will use two 80-ton rotating furnaces and is expected to produce about one-half million tons of ingots annually for rolling into high grade ship plate and other heavy plate for high quality purposes.

The vessel employed in the Kaldo process is pear-shaped, quite similar in appearance to the familiar Bessemer converter. In contrast to bottom-blown bessemer vessels and the top-blown oxygen vessels, the Kaldo vessel, while operating, is tilted to about 15 to 20 deg from the horizontal and, in this position, may be rotated at up to 30 rpm.

Although the oxygen consumption for refining pig iron by the Kaldo process is substantially higher than for the top-blown oxygen method, this may not be economically unfavorable since the Kaldo process, without the bath picking up nitrogen, can apparently use oxygen of lower purity than can the top-blown process.

Oberhausen Rotary Furnace

The Oberhausen rotary furnace employs the same rotary principle as the Kaldo furnace except that speed of rotation is much slower, being only ½ to 2 rpm. The Oberhausen furnace has the appearance of a rotary kiln. The kiln-shaped furnace is charged and tapped at opposite ends, whereas the Kaldo furnace is charged and tapped through a single port. A distinct feature of the Oberhausen process is the use of two oxygen lances, one of which is immersed in the metal bath and injects a high purity oxygen while the other lance blows low purity oxygen (as low as 45% oxygen) above the bath for burning the CO evolved by the bath reactions to CO_2.

Similar to the Kaldo furnace, larger amounts of iron ore, limestone, or steel scrap can be processed in the Oberhausen furnace than can be processed in the conventional Thomas converter. Likewise, dephosphorization proceeds simultaneously with decarburization. When using only a single-slag practice, steels containing as low as 0.07 to 0.08% phosphorus and 0.003 to 0.004% nitrogen can be produced from high phosphorus Thomas pig iron. Use of a double-slag practice should produce steels with a substantially lower phosphorus content, presumably even as low as that of European basic open hearth steels.

At present, there are two rotary furnaces operating at Oberhausen, a 60-ton and a 100-ton furnace, with a total annual capacity of 480,000 tons of steel. It has been announced that two Oberhausen rotary furnaces, each of a 100-ton capacity, are being installed in a plant in South Africa to produce 1,080,000 tons annually.

Other significant European developments include: growing use of beneficiated burdens and, particularly, self-fluxing sinter in blast furnaces, operation of blast furnaces with a second ring of tuyeres located at the bosh level, direct reduction methods for processing low grade ores unsuitable for direct use in the blast furnace (the Krupp-Renn process), partial reduction of high grade ores in the Wiberg furnace, desiliconizing and desulfurizing of hot metal prior to its use in steelmaking furnaces, oxygen roof jets in open hearth furnaces for accelerating refining of the metal, the wide use of basic refractories for open hearth roofs, walls, and checkers, and continuous casting of steel. These developments and those covered in greater detail demonstrate the intense effort and ingenuity of European steel technologists in their search for a better way to make quality steel at the lowest cost from their available raw materials.

To Order Paper No. 30C . . .
. . . on which this article is based, turn to page 5.

$677 Per Hour—

Just to Fly *Faster!*

Based on paper by

J. D. Donaldson

Convair Division, General Dynamics Corp.

Abridgment of an

SAE San Diego Section Paper

CALCULATED direct operating cost of the 88-passenger Convair 880 jet transport is $677 per hr, if the Standard Air Transport Operating Procedure is modified (as we think it should be for a realistic figure) for a 10-year depreciation period and the $20-per-hr engine material cost guaranteed by the engine manufacturer.

A camparison of direct operating cost of the Convair 880, Douglas DC-7C, and Convair 440 is presented in Table 1. The first item is crew cost, computed on a fairly firm basis starting with pilots' contracts as they exist today. Crew costs are based on a basic wage allowance for airplane weight, day or night flying, and the speed of the aircraft. Pilots' pay is directly affected by the speed of the airplane, and it has been said that pilots can increase the block speed of an airplane more in 5 min than the designers could in 5 years of hard work. The Captain's pay for the 880, working an average of 80 hr a month, totals $27,000.

Fuel costs are about 5½ times greater for the 880 than the 440 and represent 35–40% of the total cost. Jet fuel on a per pound basis has been computed to be about 50% cheaper than fuel for the other aircraft. A cost of 14.5¢ per gal may or may not be a good guess. As yet it is not known whether JP-4 or kerosene will be used. In the ATA method, $7.50 is allotted for oil costs. Indications are that oil costs will be less than $1 per hr.

Insurance and injury includes only the aircraft and third-party liability. Passenger and freight insurance is classed as indirect expense.

Maintenance items are fairly small with the exception of engine parts. Apprehension regarding this item has forced jet-engine manufacturers to guarantee the parts cost for the first few years of operation. The last column in Table 1 shows this guarantee reducing the parts cost approximately $41.50. The ATA figured the time between overhauls for comparative purposes to be 750 hr for turbine and 1300 for the well-developed reciprocating engines. The manufacturer's guarantee on jets would correspond to an ATA estimate for a 1300-hr time between overhauls. Having guaranteed the parts cost, manufacturers will strive to get the time between overhauls up as fast as possible and the ultimate will probably be around 2000 hr. The scant evidence available indicates parts cost will probably be cyclic, reaching its peak at the end of 3 or 4 years when the expensive parts will need replacement. Without guarantees, the engine price is the basis for computing parts cost.

Labor Costs Small But Important

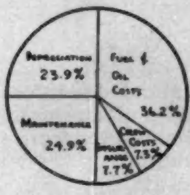
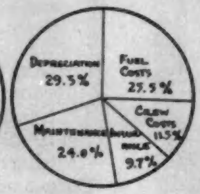
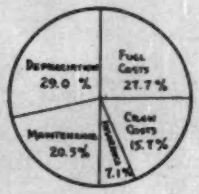
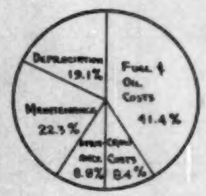
Labor costs are based on weight of the airframe or engine; material costs are based on the price of the airframe or engine. Although three of these four direct maintenance items are a small percentage of the total, do not underestimate their importance. If increased, the aircraft may be unable to meet schedules, the airplane if not completely grounded is subject to many delays. Such an operation could ruin an airline. Some manufacturers have a reputation for designing aircraft that are quite reliable and easy to maintain. To weigh this factor is beyond the scope of the ATA formula; it should be done by top executives before purchase.

Operators amortize equipment in order to be able to buy new aircraft when the old is obsolete. The old is usually assumed to have a residual value of 10% of its purchase price. An airplane purchased today for $3,500,000 would have $3,150,000 accumulated in its depreciation account at the end of a given period, but instead of being worth $350,000 (as used in the computation) it would probably be worth $3,500,000, if past experience foretells the future. Therefore, the operator would really have $6,650,000 available for new equipment. Ironically the new equipment will probably cost 12–15 million.

Realistic Depreciation

The ATA recommends a 5-year depreciation period for aircraft in the $500,000 to $1,000,000 class. The 440 falls in this class. For higher priced equipment a 7-year period is recommended. It is believed this results in an unfair comparison. Faced

Table 1—Comparison of Direct Operating Cost of Convair 880, Douglas DC-7C, and Convair 440.

	STANDARD ATA COST METHOD OF 1955 15 MILES PER HOUR HEADWIND AND ISA CONDITIONS			Modified ATA Method: 10-year depreciation $20 per hour Guaranteed Engine Material Costs
	1,000 STATUTE MILE RANGE		500 STATUTE MILE RANGE	1,000 STATUTE MILE RANGE
	CONVAIR 880	DOUGLAS DC-7C	CONVAIR 440	CONVAIR 880
Flying Operations:				
Crew	56.83 (3 Crew)	46.24 (3 Crew)	28.84 (2 Crew)	56.83 (3 Crew)
Fuel and Oil	280.02	102.13	50.89	280.02
Insurance and Injuries	59.70	38.96	13.02	59.70
Direct Maintenance:				
Labor - Airframe	28.74	24.82	14.67	28.74
Labor - Engines	12.76	13.14	4.76	12.76
Material - Airframe	29.59	20.15	6.78	29.59
Material - Engines	121.52	38.52	11.19	80.00
Depreciation:				
Airframe	121.98	80.90	36.76	85.39
Engines	26.54	14.22	5.79	18.58
Propellers	-	2.55	1.44	-
Radio	3.81	3.81	2.33	2.66
Airframe Spares	12.60	8.59	4.03	8.82
Engine Spares	19.90	7.10	2.89	13.93
TOTAL - DOLLARS PER HOUR	773.99	401.13	181.35	677.02
Block Speed (miles per hour)	486	303	233	486
Block Fuel (lbs.)	25,150	9,400	3,050	25,150
Direct Operating Cost - Dollars per airplane Statute Mile	1.592	1.322	0.787	1.393
Number of Seats (Standard Configuration)	88	67	44	88
Direct Costs - Cents per Seat Mile	1.81	1.97	1.79	1.58
Actual D.O.C. (Ref. Gotch and Crawford - dollars/hour)		478.11 (DC-7)	180.96	
Percentage Break Down of Costs, Based on ATA Method.				

with the choice of purchasing a $2,000,000 or a $3,500,000 article, the operator will elect the more expensive only if it will make more money and have a longer useful life. We believe an airplane as expensive as the 880 should have a 10-year depreciation period. This, coupled with an engine parts cost guarantee, reduces the hourly operating cost for the 880 by $100.

The ATA method calls for 50% reserve engines and engine parts for the reciprocating engines and 75% for turbines. This may serve as a guide for initial capital expenditure for engines by the first few purchasers, but at the close of the depreciation period the operator will not have 75% engine spares on hand. A fair percentage will have been used up and not replaced.

The computed direct operating costs compared to actual costs as reported to CAB and published in Gotch and Crawford are shown in Table 1 for the two aircraft now operating. Reported costs are an industry average and quite close to computed costs. Since actual costs for the DC-7C could not be located, the cost for the DC-7 is shown. DC-7C computes out at about a 5% increase over the DC-7.

Indirect Operating Costs

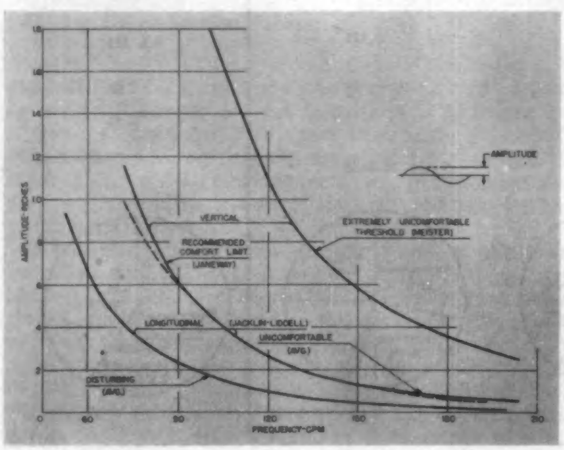
The indirect costs must be added to the direct operating costs. The former run from 60 to 130% of the direct costs. They will be low for a cargo carrier. A small- or medium-size airline with a good route structure will have a small indirect expense. Short-range operation adds greatly to the indirect expense due to the many stations to maintain. A large operator, covering a large territory, especially outside the continental United States, may have to maintain stations with ground support into which one flight a week is scheduled. Although indirect expense is primarily a factor of passenger-miles or ton-miles flown, it is greatly influenced by all the previously mentioned factors and by others not discussed.

To Order Paper No. S54 . . .
. . . on which this article is based, turn to page 5.

8 points to check for

Improving

1. How Much Shake Can the Driver Take?



Vertical and longitudinal (fore-and-aft) vibrations both contribute to driver discomfort. The latter is more critical, probably because the human body is inherently not adapted to resist fore-and-aft forces. The frequency-amplitude curves correspond to nearly constant values of maximum rate of change of acceleration ("jerk") at a given reaction level. This holds for frequencies of 1 to 6 cps, covering the principal ride range.

The values of jerk for the curves are:

	Jerk In./sec^3	Jerk af^3
Vertical		
Recommended comfort limit	500	2.0
Threshold of discomfort	700	2.8
Threshold of extreme discomfort	2400	9.6
Fore-and-aft		
Disturbing (average)	150	0.6
Uncomfortable (average)	450	1.8

A maximum vertical acceleration of $0.6g$ is set for the cargo to insure it doesn't leave the floor.

The complete paper on which this article is based is a combination of a report on the work of a special SAE Joint Subcommittee on Tractor-Trailer Ride and subsequent work done by Janeway.

Members of the Subcommittee and their affiliations at the time the report was issued were:

R. N. Janeway, Chrysler Corp.
Watson Ford, U. S. Rubber Co.
H. E. Fox, Truck and Coach Division, GMC
E. P. Lamb, Chrysler Corp.
W. F. LeFevre, Freightliner Corp.
Maurice Olley, Chevrolet Motor Division, GMC
F. E. Sandberg, Ford Motor Co.
A. E. Williams, Fruehauf Trailer Co.

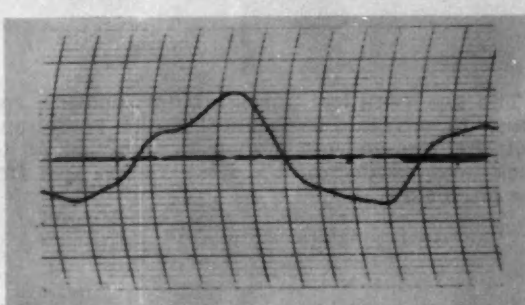
To Order Paper SP-154 . . .
. . . on which this article is based, turn to page 5.

Based on paper by **R. N. Janeway,** Janeway Engineering Co.

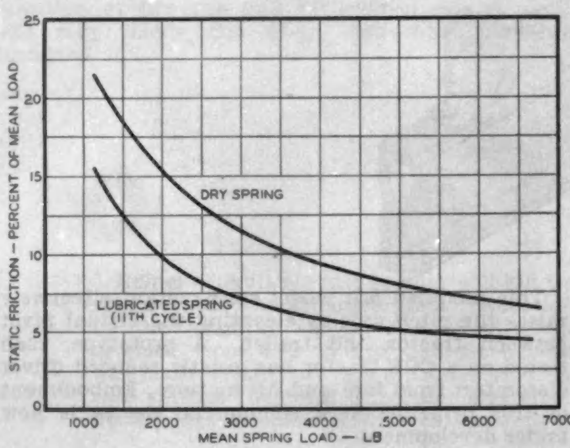
Truck Ride

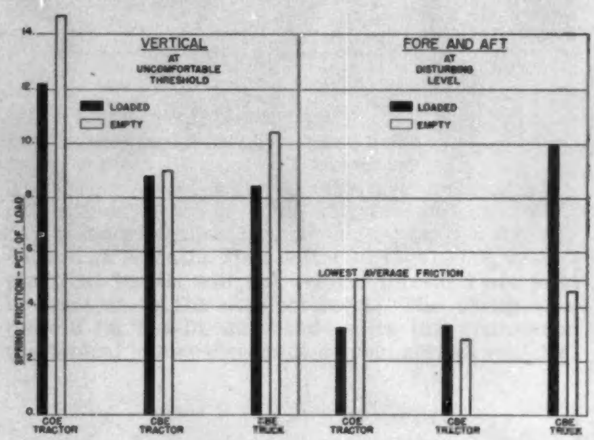
2. Cut Spring Friction.

High spring friction means driver discomfort because the truck is "riding on the tires alone." The springs don't help ride until the force of a bump is great enough to overcome the static friction in the springs.



This acceleration record of vehicle vibration on a leaf spring and tire in series shows that the spring only works part of the time even when the maximum force exceeds the friction. The initial motion, following the peak amplitude, is at a higher frequency (on tire alone) than the later phase of the vibration when tire and spring are both acting.





The end effect of spring friction on driver comfort depends on the type of vehicle. Plots of maximum allowable spring friction for driver comfort show the COE and CBE tractors and empty trucks do not meet comfort levels in the fore-and-aft direction. This is with minimum values of friction encountered in practice (5% of load). If spring friction is doubled, all but the COE tractor in vertical motion would be at or above the discomfort level.

New springs can go well over the 5% minimum if they are lightly loaded or not lubricated. Used springs often have increased friction because of rust and corrosion.

Good ride with leaf springs demands:

a. Effective interleaf lubrication.

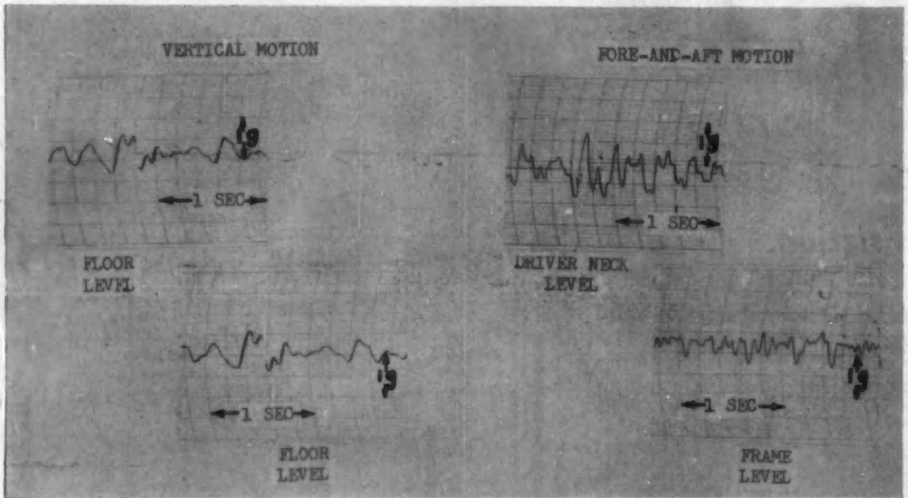
b. Protective spring covers to retain lubricant and exclude contamination when grease lubrication is used.

c. Design for minimum number of leaves, mininum nip, and tapered leaf ends.

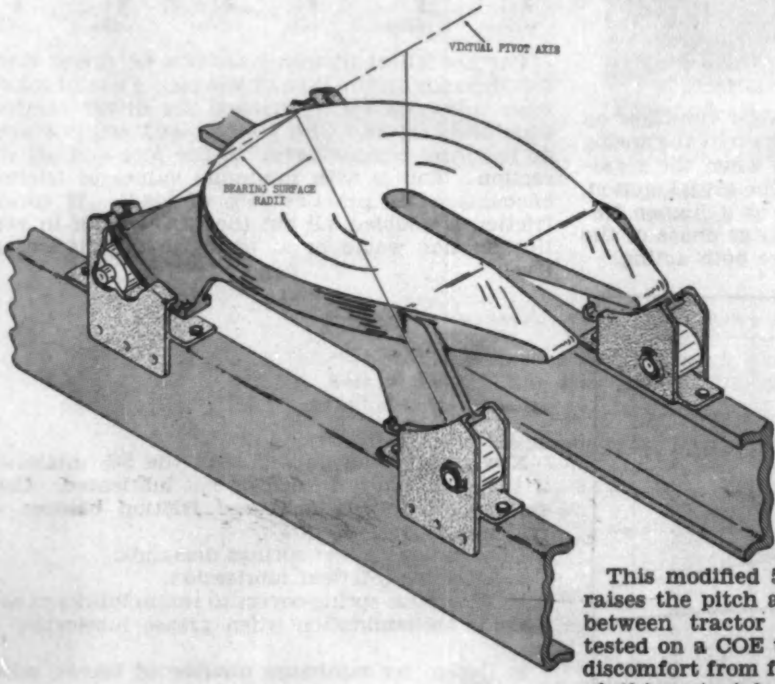
Continued

3. *Raise the Pitch Axis.*

The damaging fore-and-aft motion is actually due to a rotation about the pitch axis of the vehicle, which, in a tractor with semitrailer is below the top of frame. If the center of rotation were at the driver's neck level, this motion would be negligible.

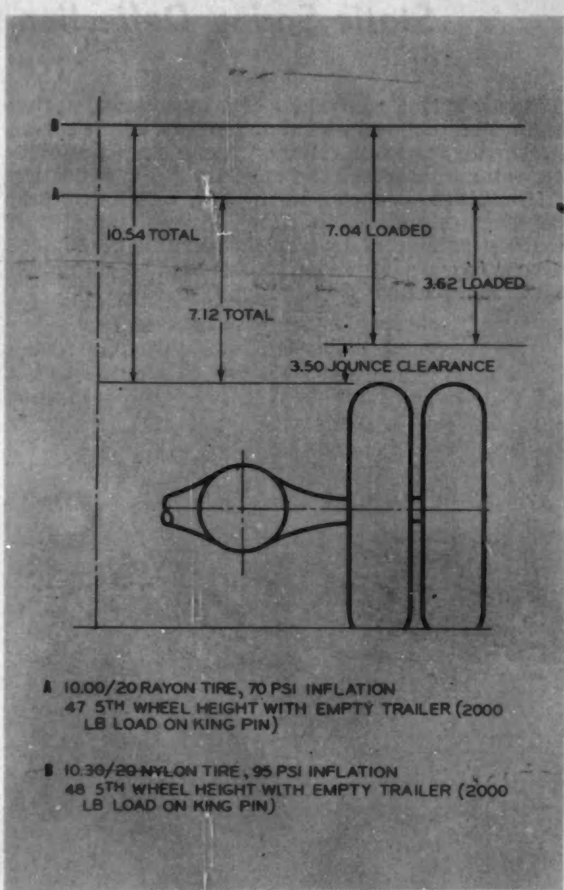


The two vibration traces are for identical road runs. In each case the vertical motion is the same. But the fore-and-aft motion is amplified at the neck level because of the large radius arm from the pitch axis.

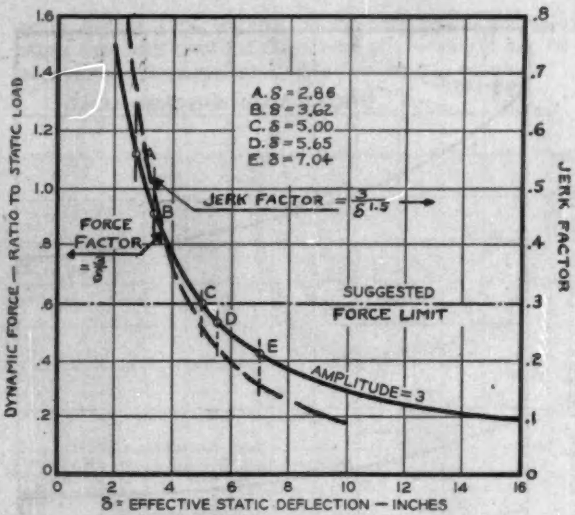


This modified 5th wheel construction effectively raises the pitch axis by elevating the virtual pivot between tractor and trailer. A prototype, road tested on a COE tractor has greatly reduced driver discomfort from fore-and-aft motion. Embodiment of this principle in a commercial device is now under development.

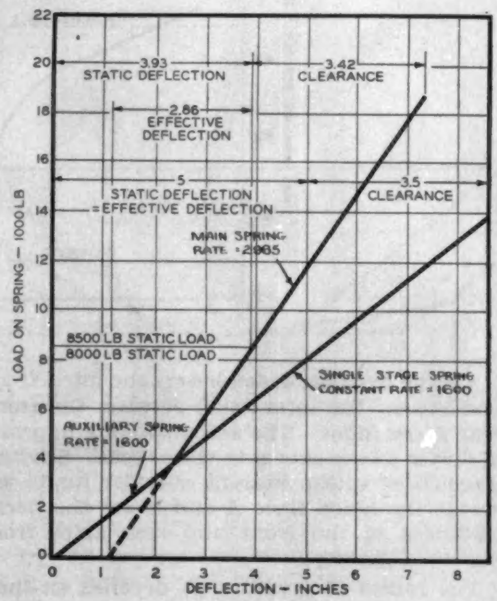
4. Increase the Effective Static Spring Deflection.



Vehicle design is one way to get more spring deflection. Variations in design can give from 3.62- to 7.04-in. loaded spring deflection by the proper selection of tire size and fifth-wheel height, and still stay inside the 48-in. fifth-wheel height standard.



Increasing the effective static deflection is basic in reducing both the jerk on the driver and acceleration applied to cargo. A minimum deflection of five inches is necessary to meet the recommended cargo limit of 0.6 *g*. This will also give generally satisfactory vertical jerk level for the driver. Although an essential step, softer springs alone, within practical limits, will not reduce fore-and-aft jerk in tractors to the comfort level. The graph was plotted for a 3-in. amplitude since this represents the typical jounce clearance on commercial vehicles.



Helper or multiple rate springs will kill the loaded ride because the effective static deflection is cut. In the example shown, the effective deflection dropped from 3.93 to 2.86 because a compromise was made to improve the unloaded ride. In single rate springs the total deflection and effective deflection are the same, 5 in. in this case.

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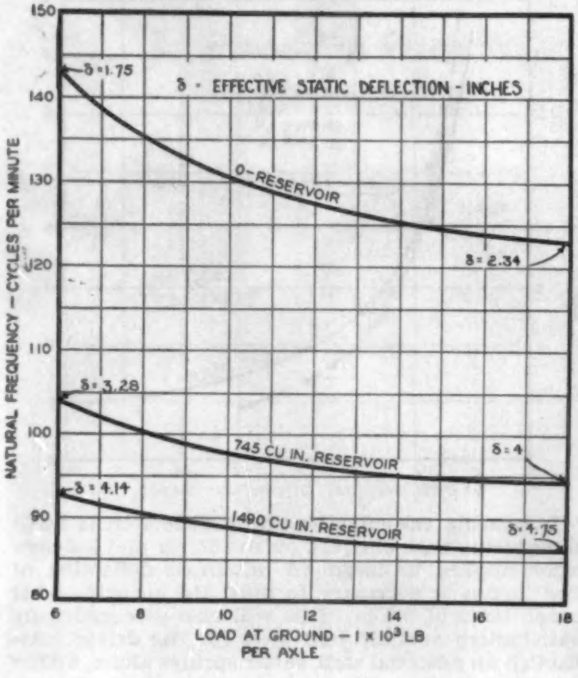
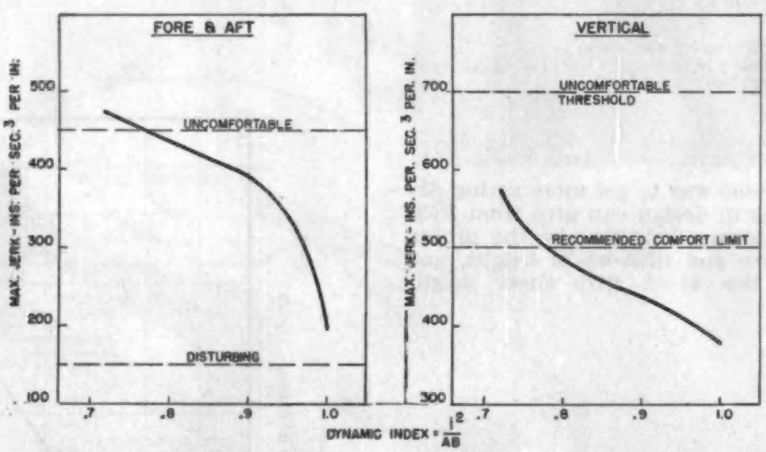


4. *Increase the Effective Static Spring Deflection.*

Continued

The air spring equivalent of a mechanical spring depends on the mechanical dimensions of the spring and the air reservoir volume. Increasing the reservoir volume increases the effective static deflection of the spring, as shown in the graph. The natural frequency of the system drops correspondingly. A reservoir volume of 1490 cu in. per unit is required in this case to approach recommended minimum static deflection of 5 in. under full load.

5. *Increase the Dynamic Index.*



A large dynamic index lowers the pitch frequency and lessens the interaction between the front and rear suspensions. The accompanying improvement in driver ride is shown in the graphs. Shorting the wheel base within braking stability limits will increase the index since A and B are the horizontal distances to the front and rear axles from the center of gravity.

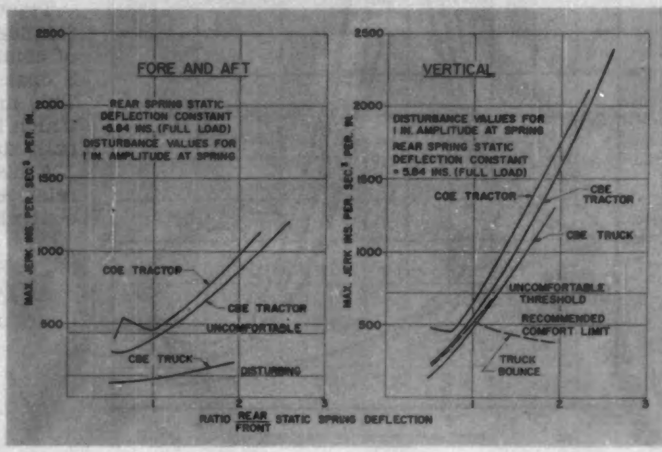
The radius of gyration (i) depends on the mass distribution of the vehicle. Concentrating the mass about the center of gravity will have an adverse effect. Raising the effective pitch axis, as in second figure of point 3, increases the radius of gyration and makes it possible to practically approach a dynamic index equal to 1.0.

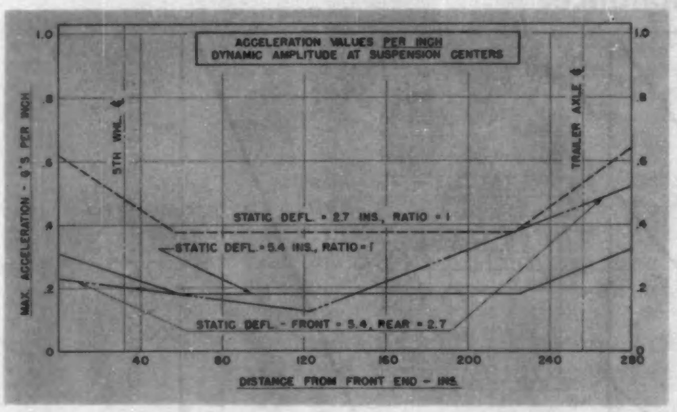
The example is for a loaded COE tractor with constant static spring deflections of 5.0 in. front and 5.7 in. rear. Jerk values are per inch of amplitude at the spring.

6. *Pick the Best Combination of Spring Deflections at Each Axle.*

The characteristic motions at any particular point in a vehicle can be varied by changing the ratio of front and rear spring deflections. It is possible to get a better ride in one portion of the vehicle by using two different deflections than would be obtained by using either deflection at all wheels.

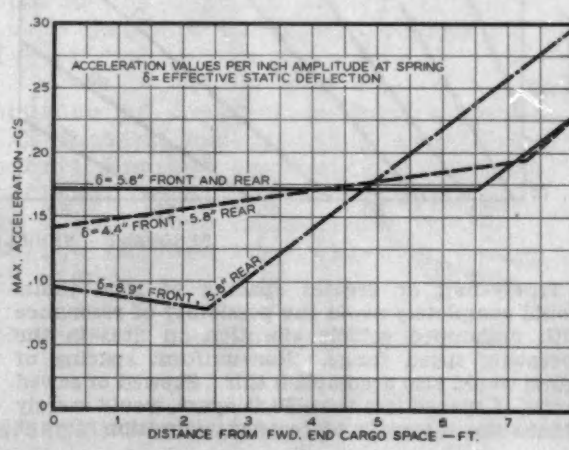
The ride of the driver is shown for all common commercial vehicles as a function of deflection ratio taking a constant rear spring deflection of 5.8 in. Here there is continuous improvement as the static deflections approach equality due primarily to the increasing deflection at the front end. Actually, this also shortens the radius about the pitch axis which is unfavorable to the fore-and-aft disturbance.





A sizable improvement in cargo ride is possible over most of the length of a semitrailer just by increasing the static deflection at the tractor rear end.

A differential spring deflection between front and rear improves the ride in the forward half of a truck cargo space, even when the rear deflection is higher.



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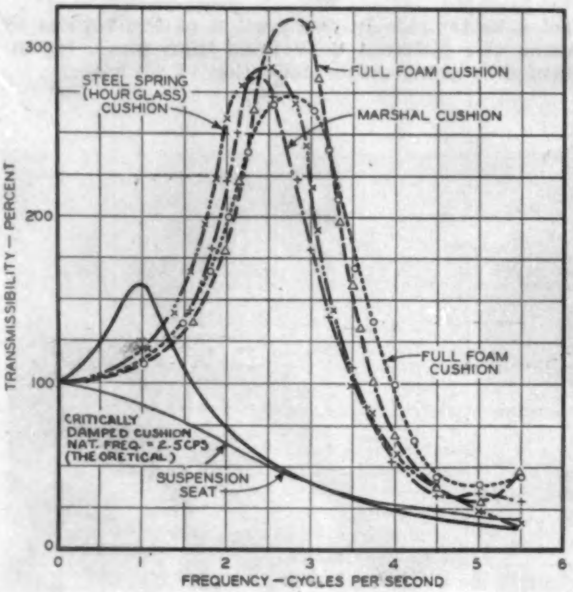
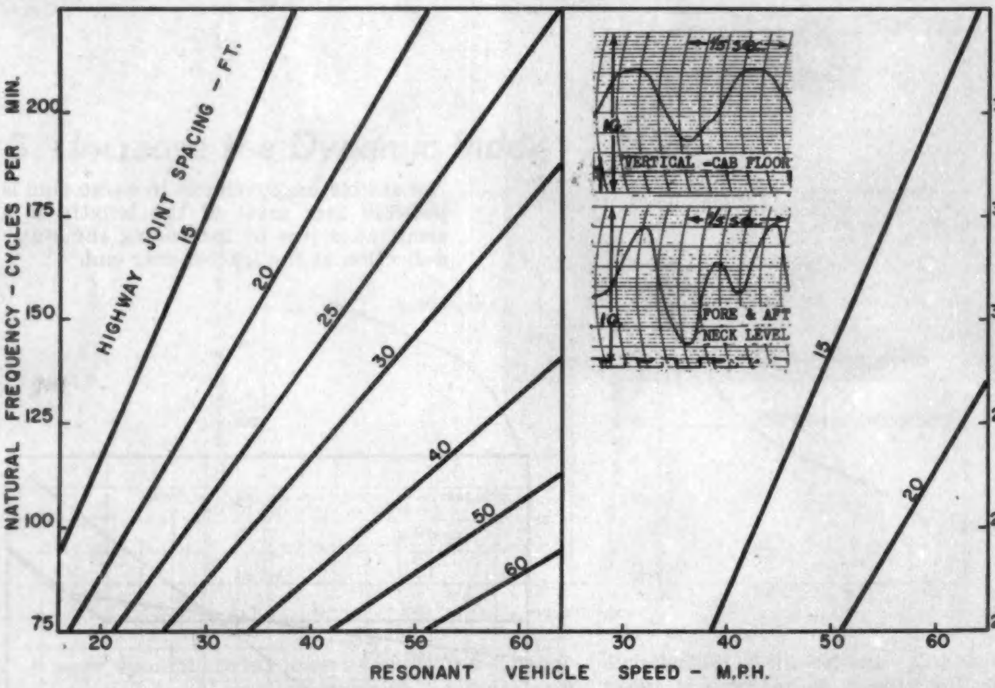


7. Damp the Seat Cushions.

Typical seat cushions of today have a natural frequency under the driver's weight close to that of commercial vehicles on their suspensions (2.5 to 3 cps). Most seats have little internal damping. This means the cushion can produce a driver ride which is worse than sitting on a hard seat. A critically damped cushion would avoid this effect.

A suspension seat can also be used. However, the relative motion between the driver and the truck controls can be excessive with this arrangement.

8. Future Roads without Resonance.



Thirty-foot or greater spacing of road joints would completely avoid the possibility of resonance with undamped vehicle vibration on tires in the operating speed range. Non-uniform spacing of joints would also accomplish this. Skewed or sawed joints, if spaced less than 30 ft apart, would merely reduce the intensity of resonant vibration.

The relation between vehicle speed and joint spacing is shown in the graph. The effect of this resonance on tires is demonstrated in the traces of vertical and fore-and-aft accelerations obtained in a typical vehicle traveling 41 mph over a road with 15-ft joint spacings.

SAE LOOKS OVERSEAS

by **DAVID KRAVITZ**, service methods engineer, Wright Aeronautical Division, Curtiss-Wright Corp. These observations grew out of a visit to England to inspect jet engine overhaul operations.

Certain English jet engine manufacturers have been overhauling American-made jet engines for aircraft based overseas. American-recommended tooling includes a roll-over type of engine maintenance and overhaul stand. The advantages of this stand have resulted in its acceptance as a unit of handling equipment in the overhaul of English-made jets.

The standard features of the American roll-over stand, however, are not incorporated in the English stands that were observed. English roll-over rings are designed to fit a particular engine; length and width of base frame are tailored for the specific engine at the overhaul depot.

BRITISH OVERHAUL AT FACTORY

Usually, the English engine manufacturer will see his engines returned to him for overhaul. Military jet engine overhaul depots do not exist as such, and the problem of overhauling engines of different manufacturers at a single depot is non-existent.

American military practice of performing overhaul of several types of engines at a particular overhaul depot emphasizes standardization of handling equipment. SAE ARP-458A on the design of a Universal Maintenance and Overhaul Stand was prepared as a joint effort of the U.S. Air Force, Navy, U.S. jet and turboprop engine manufacturers, and SAE.

CASTERS ELIMINATED — CRANE HANDLES ENGINE

Of interest is the absence of casters on English manufactured stands. The SAE Tooling Subcommittee considered casters advisable to permit limited movement of engines in stands on the depot floor. In all cases at the English overhaul depot the movable overhead crane is required to handle the engine between the roll-over stand and an engine-transport stand.

The absence of casters lowers the frame of the stand

(Continued on next page)

This feature is an activity of the SAE OVERSEAS INFORMATION COMMITTEE, M.A. Thorne, chairman

to the floor, with the result that load-carrying ability of the frame is no longer critical. The frame, therefore, is of light-weight box construction. Roll-over rings are of this same material, as a contrast to the American practice of utilizing a standardized Tee section for the rings. Mechanical driving of the ring, a feature of American design, is not incorporated in the English stand.

ROLL-OVER STAND USED FOR ACCESSORY INSTALLATION

The roll-over stand is used in the horizontal final assembly of a portion of the engine. Installation of accessories and preparation of engine for test run are also performed on this stand. Personnel were high in praise of this unit of equipment, which, with the roll-over feature, permits positioning of the engine for ready access to the entire outer surface.

The caliber of the assembly mechanic at the English overhaul depot bordered on the level of machinist. More leeway in the fitting of parts was noted than that which would be considered standard American recommendations.

DETAIL CLEARANCE AND FITS RECORDS KEPT

Inspection work load is high. Detailed records are kept on clearances and fits. American procedure is to check only the equipment for which adjustment at time of assembly is provided.

DYE PENETRANT FOR CRACK DETECTION

Extensive use is made of the dye penetrant method for crack detection. The red dye is conveniently located in inspection areas in vats of adequate size to handle components other than compressor housings. Housings are dipped in heated oil in lieu of dye. Small details such as compressor and turbine blades are stacked in racks, and a full set is dipped in the dye. Fine chalk suspended in a suitable liquid is sprayed by air gun onto dye-dipped parts after a quick cleansing operation. Oil dipping is followed by a cleansing operation and a dry chalk application. Airgun and special exhaust booths are provided.

VIBRATION RARE IN BRITISH OVERHAULS

Balancing operations were performed mostly on American equipment to very close limits. British overhauled engines have the reputation for being "non-vibrators;" premature removal from airframes for excessive vibration is a rare occurrence. This proof of confidence is further exemplified by the complete lack of vibration detecting equipment in the engine test cell. A high production rate could conceivably alter the relatively expensive practice of balancing "down to zero."

Abridged from an

SAE Metropolitan Section Paper

Trends in Diesel Lubes:

. Increased use of cross-graded oils
. More and stronger additives

Based on paper by

E. M. Johnson and H. V. Lowther

Socony Mobil Oil Co.

USE of cross-graded oils is growing, the additive content is being increased, and more potent additives are being sought. These are the current developments which suggest what lies ahead for diesel lubricants.

Use of Cross-Graded Oils

Multigrade oils have proved their worth in passenger-car engines and are about to do the same in gasoline and diesel commercial car engines. If properly formulated, cross-graded engine oil can render the fleet owner the following benefits:

1. Eliminate cold-weather starting difficulties.
2. Improve wear protection.
3. Give clean engine conditions under all types of service.
4. Improve fuel economy.
5. Reduce the number of brands and grades normally required for fleets of mixed vehicles.

To determine the reliability of an SAE 10W-30 oil under severe service conditions, tests were made with a heavily loaded GMC 3-71 engine. The tests were run for 200 hr under a cyclic condition of 10 min idle and 10 min at 1800 rpm, 91-bhp output. The SAE 10W-30 and MIL-L-2104A SAE 30 oils behaved identically as regards piston-ring and cylinder wear. Both gave good cleanliness ratings, but oil and fuel consumption were lower with the 10W-30 oil.

A diesel-engine field test to compare the two oils yielded results of even greater significance. This test was carried out with 12 heavy-duty cross-country hauling trucks powered with GMC 4-71 diesel engines. The average mileage was 5300 miles per truck per month. Because of the limited number of vehicles on each oil, fuel and oil economy were compared to the previous year's service in the same trucks on an SAE 30 oil, the same oil as used for reference during the test.

Table 1 shows the results of the test. Less fuel economy was lost with the SAE 10W-30 oil than with the SAE 30; oil economy loss was greater with the SAE 30 oil than with the cross-graded 10W-30. On direct comparison, the 10W-30 oil gave far less sludge deposit. This was most apparent on air box surfaces and port openings.

These data indicate that a properly designed SAE 10W-30 oil will give excellent service in heavy-duty diesels. As more experience is had with the cross-graded oils demand for them should grow.

Additives

The volume of Series 2 oils rose rapidly from 1949 to 1954. Then in 1955-1956 the Series 3 oils captured the bulk of the heavy-duty oil market, with a corresponding drop in Series 2 oils. The use of Series 2 and 3 products together has increased 15-fold in eight years and is expected to mount still higher. As a result, the oil producer is confronted with two questions: (1) Will higher additive oils be needed? (2) How can a more potent additive combination be developed?

Changes in engine design to satisfy fleet operators will decide the first question. If more power is packed into smaller engines, more severe lubrication requirements will be the outcome. The future of additive potency is difficult to predict. The present Series 3 oils require very high percentages of additive. Thus, to obtain maximum performance at minimum cost the search for more effective and lower cost additive ingredients must continue.

To Order Paper No. S60 . . .
. . . on which this article is based, turn to page 5.

Table 1—Field Test Results—SAE 30 versus SAE 10W-30 Oils

(Test vehicles: GMC 4-71 tractors; 68,000 lb gvw; 5300 miles per month per truck)

	SAE 30 MIL-L-2104A	SAE 10W-30 MIL-L-2104A, Supplement I
Fuel Economy Loss:		
Per cent compared to pretest period	- 5.7	- 2.3
Oil Economy Loss:		
Per cent compared to pretest period	- 33.0	- 22.0
Engine Sludge Deposits Demerits (average)	49.8	20.3
Piston Deposits Demerits (average)	47.5	42.5

Step Up Range with

Range increases directly with the heating value of the fuel. High energy boron compounds need stability and deposit control to make them operational.

Table 1 — Properties of Boron Hydrides

	Diborane B_2H_6	Pentaborane B_5H_9	Decaborane $B_{10}H_{14}$
Melting Point, F	−265.9	−52.4	209.7
Boiling Point, F	−134.6	136.4	415.
Specific Gravity, 60/60	0.21	0.63	0.78*
Viscosity at −40 F, CS			
Heat of Combustion, Btu/Lb	31,330.	29,130.	28,300.
Lb B_2O_3/Lb Fuel	2.5	2.76	2.85
Lb B_2O_3/100,000 Btu	8.0	9.48	10.

* At 212 F.

Based on paper by

Walter T. Olson, Lewis Flight-Propulsion Laboratory, NACA

BORON compounds offer a heat of combustion 40% greater than that of aircraft fuels in current use. Diborane and pentaborane have burned satisfactorily in turbojets, afterburners, and ramjets. But boron compounds leave troublesome deposits and they present supply, storage, and handling problems.

Hydrides of boron have been investigated in attempts to find a usable high energy liquid fuel. (The ultimate fuel is now thought to be a boron-hydrogen-carbon compound.) Properties of the hydrides are shown in Table 1. For comparison, the heating value of jet fuel JP-4 is 18,620 Btu per lb.

The complete paper on which this article is based also contains a survey of other high energy fuels such as: magnesium, aluminum, beryllium, and titanium. Problems and advantages of solid boron in slurries of JP-4 fuels are discussed. However, handling experience indicates the use of liquid boron compounds.

Magnesium shows up as a top fuel for short-time high-thrust applications, this is because of its high combustion temperature.

Forty references are given for papers and articles on high energy fuels.

To Order Paper No. 41B . . .
on which this article is based, turn to page 5.

Boron Hydrides versus Hydrocarbons

Some comparisons between the two types of fuels are:

- Vapor pressure — Diborane (B_2H_6) is between ethylene and ethane; pentaborane (B_5H_9) falls a little below cyclopentane; and decaborane ($B_{10}H_{14}$) is similar to dodecane.
- Freezing point of pentaborane is higher than most C_5 or C_6 hydrocarbons.
- Alkyl groups combine with boron hydrides to give a whole range of physical properties analogous to hydrocarbons.
- Fuel system materials, such as copper, aluminum, tin-lead solder, paper, asbestos, and graphite, appear suitable with both fuels. But natural and synthetic rubbers lose strength and polyfluorethylene plastics are needed for gaskets and seals when boron hydrides are used.

How Good is Boron as a Fuel?

The high heating value of boron compounds is known but combustion, handling, and storage properties are just as important if boron is to be a successful fuel. JP-4 jet fuel is the competitor to beat, when we recognize that engines could be designed to match boron fuel properties better.

Thermal decomposition of three boron hydrides is shown in Fig. 1 with JP-4 fuel added as a comparison. Here pentaborane shows up 100 times more stable than diborane. Insoluble materials and gases, which will plug fuel systems and cause vapor lock, are produced from decomposition of boron hydrides.

Combustion studies demonstrate that diborane will burn in 1–2% mixtures with dry air at atmos-

Boron Compound Fuels

pheric pressure; 95% diborane and 5% oxygen will also burn. Pentaborane has a similar lean burning limit of 1–2%. However, rich flammability limits have not been found because the vapor pressure of pentaborane is too low to prepare a rich enough mixture.

Diborane is not spontaneously flammable in dry air, while pentaborane is in the range shown in Fig. 2.

Flame speed of 100 times that of hydrocarbon mixtures is reported for diborane by the General Electric Co. Pentaborane speeds are in the same range. This fact can help jet engine burner design by eliminating the strong reverse flow usually designed into hydrocarbon burners to "pilot" the flame. Without the piloting action, boron fuel deposits can be minimized.

Boron hydrides are as toxic as chlorine and react with water. In fact, diborane is completely hydrolyzed in less than a minute. Pentaborane and decaborane hydrolysis depends on the rate of contact with water since they are insoluble in it.

Boron oxide (B_2O_3) as a deposit in combustion chambers was quite dramatic when a standard turbojet chamber was used in early tests (see Fig. 3). This glass-like oxide has a high viscosity at normal turbine operating temperatures. Flow patterns in the engine must keep the oxide away from the walls. Surfaces that must be contacted by the oxide should be 1070 F or higher — the approximate melting point of the oxide. At the same time the boron fuel must be kept cool so it won't decompose and plug the fuel line, thereby lowering the combustion-chamber temperature and accelerating deposit growth.

Afterburners and ramjets have fewer problems because no moving part comes into contact with boron oxide. The reverse temperature problem is present in that above 3000 F considerable heat goes into vaporizing boron oxide. This heat loss shows up as poor specific fuel consumption. If the exhaust stream is expanded to a lower static temperature and pressure some, but not all, of the performance can be recovered.

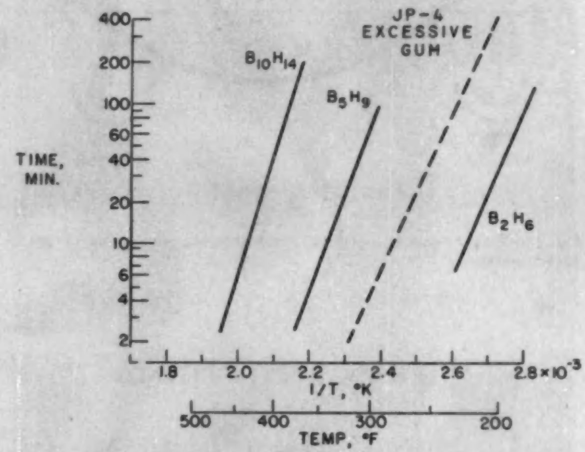


Fig. 1 — Five per cent thermal decomposition of boron hydrides is compared with the corresponding thermal gum formation problem of JP-4 jet fuel. Pressure is one atmosphere.

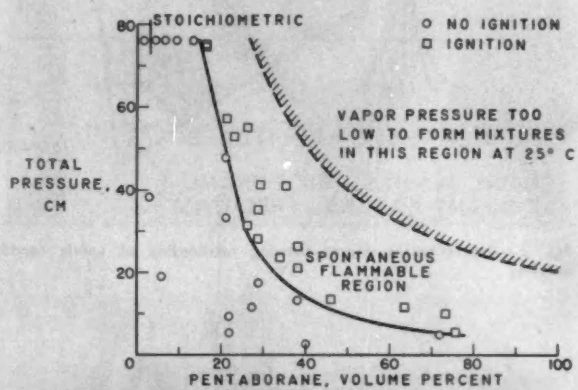
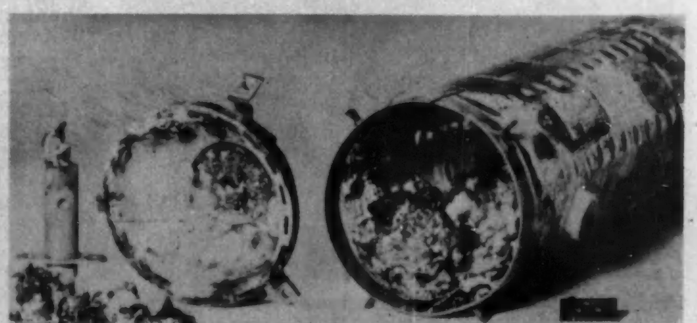


Fig. 2 — Pentaborane will ignite spontaneously in the region where test points show as squares. Test temperature is 25 C.

Fig. 3 — The high melting point of boron oxide makes the use of standard combustion chambers impractical. This product of combustion of boron compounds melts at 1302 R.



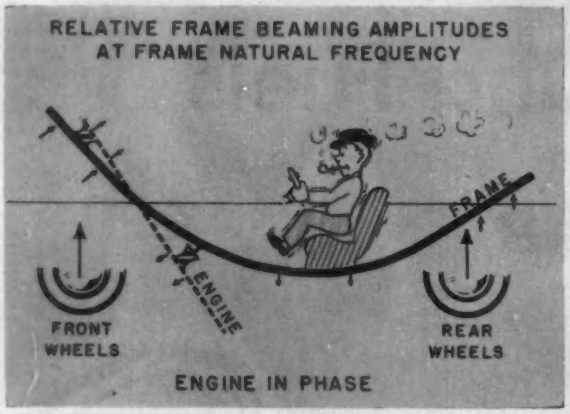


Fig. 1 — Frame beaming — typical graph showing relationship of poorly tuned mounts.

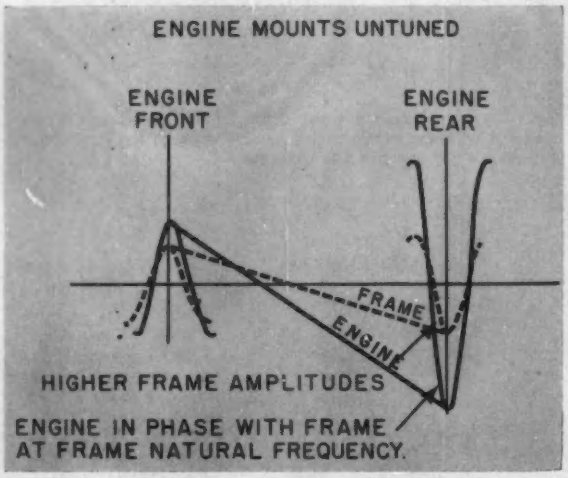


Fig. 2 — Instantaneous curves showing relationship of poorly tuned mounts.

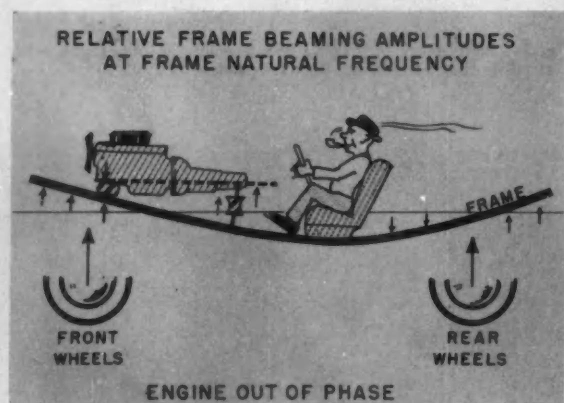


Fig. 3 — Frame beaming — typical graph showing relationship of properly tuned mounts.

Tackling

Based on paper by

L. M. Morrish

Buick Motor Division, General Motors Corp.

ENGINE mountings exercise considerable control over car shake, provided other major shake-affecting components have been designed within a reasonable limit from the optimum. No change in mounting can appreciably correct a poorly designed and weak frame structure or prevent wheel hop.

Motor mounts have very little effect on the overall static strength of a car but, by controlling the frequencies of the powerplant and the damping of its mounts, appreciable changes can be made in the behavior of the car due to the influence of the dynamic stiffness and mass of the powerplant.

Fig. 1 shows a little man shaking down the road in a car which has much wheel hop, a weak frame, and poorly tuned or located engine mounts. Note that the rear of the engine appears to be moving farther than the frame does. Fig. 2 shows the phase relationship to be such that no help can be expected from the powerplant's action as a dynamic absorber except for that energy absorbed by viscous action of hysteresis of the mounts.

Fig. 3 shows the same little man in his new car, which has been designed to reduce shake. The bounce amplitude of the man is considerably reduced and the powerplant motion relative to the frame has changed. This standard frame has been graphed to show no particular local weakness and, while it may not be ideally stiff, bending is relatively uniform. Let it be said again, no motor mount corrections can be expected to replace the need for proper structural design. A check of Fig. 4 will show that the powerplant may now have the proper phase relationship to indicate that it is working as an oversize dynamic absorber. This requires the mounting system to be tuned so that a correct phase relationship will exist at peak shake frequencies as the passenger knows them. A plot of the frame displacement curves will also indicate this.

As shown in Fig. 5, damping is advantageous in the region where the ratio of the impressed frequency to the resonant frequency approaches one (1), but for all values where the mounting can be expected to reduce transmission (of noise and vibration in this case), the presence of damping makes transmissibility worse. Fortunately, the bad effect of dampening is not severe, hence a desired mount efficiency may have a reasonable tolerance spread to satisfy manufacturing needs and to maintain optimum damping within the operating temperature variations.

It is not the general intention, of course, to design

Car Shake

Through Engine Mounts

mounts which will be required to operate continuously in an engine speed range where resonance can occur because noise and vibration problems could be severe. But most modern cars do have engine mounting systems which resonate in some mode adjacent to peak shake frequency ranges. Therefore, serious consideration must be given to the effects of tuning and damping.

If the natural frequency of the powerplant mounting is far below that of the impressed forces, the powerplant ceases to move and, as a result, will proceed down the road in a straight line regardless of the shake imposed on the frame ends of the mounts. This can result in the absorption of energy by low efficiency mounts, but it can also result in a very low frequency jack-rabbit effect of the powerplant oscillations when low frequency disturbances are imposed. Such a soft mounting would show large static deflections due to engine weight, and might require extra room due to engine roll caused by torque reaction. Suspension frequencies would introduce new problems.

Ideally, the absolute motions of the sprung and unsprung masses (here the powerplant and frame) should be damped independently. The practice of damping the relative motions between these units is a compromise. We make this compromise. The efficiency and dynamic rate are controlled in Buick mounts; durometer hardness and static spring rate are rarely mentioned.

Another important consideration affecting both tuning and damping of the mounting system is the relative mechanical impedance of the attaching parts. When using a shaker which applies a harmonic force of which the frequency can be changed gradually, we measure the force as well as the motion amplitude and the phase angle for each frequency. We then can show the mechanical impedance. This can be very important when large masses, such as powerplants, are designed to be spring-suspended from relatively light foundations such as the automotive frame.

All the considerations mentioned regarding the function of the mounts on shake can be considered ultimately as a function of mechanical impedance and impedance ratios. The dynamic spring rate of the rubber mounts must be appreciably lower than the attaching members so that a favorable impedance ratio can be noted. This requires such units as cross-members to be made relatively stiff so that maximum mount benefits will be gained.

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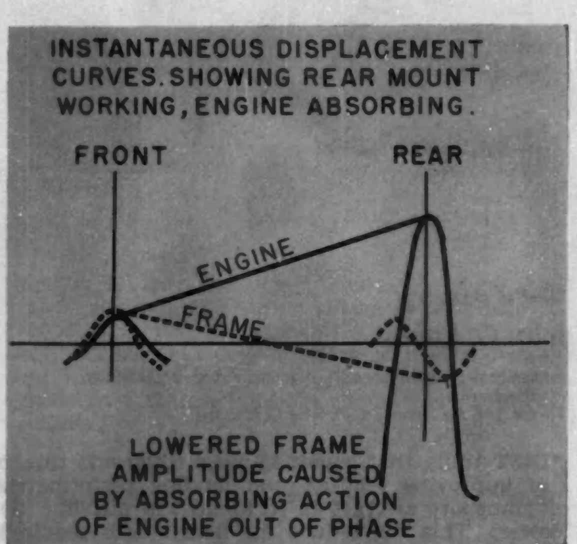

Fig. 4 — Instantaneous curves showing relationship of properly tuned mounts.

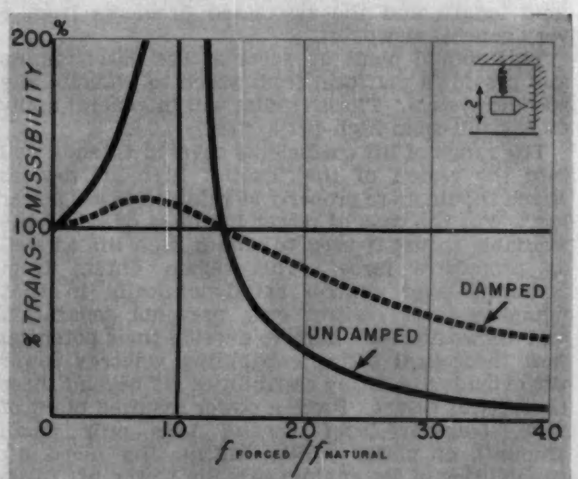

Fig. 5 — Damping is advantageous in the region where the ratio of impressed frequency to the resonant frequency approaches one (1).

How we can improve

Landing and Take-off Performance of Transport

Based on report by

John G. Lowry

aeronautical research scientist, National Advisory Committee for Aeronautics
To the SAE Air Transport Activity Committee

FIRST thing that comes to mind when one thinks of improving take-off and landing performance of transport aircraft is to make the airplane fly slower. This will reduce the field length required or allow for larger allowable take-off weights to be used on a given runway.

Unfortunately, field length is only one of the problems involved in improving the take-off and landing performance. In addition, there are such problems as climb, glide-path control, "the last 200 feet," approach speed, rate of descent, and noise, just to name a few. But let's look at reduction in field length and the associated problems from a very general viewpoint.

This should point up some of the basic factors and provide a platform from which to evaluate any specific system. These studies will in general apply to any full-span high-lift system.

The range of lift coefficients covered extends well into the region of the "exotic" high-lift devices which should more properly be referred to as "power lift." For the case of power lift most or all of the available thrust is used to obtain high lift as well as propulsive force. This region differs from boundary-layer control aerodynamically in that boundary-layer control only prevents separation and allows high-lift flaps to develop their potential flow theoretical lifting capabilities whereas power lift extends the lifting capabilities far beyond these theoretical values. From a power required point of view, boundary-layer control uses only small amounts of power — often within the bleed air capabilities of jet engines — while power lift in its most effective form would use all of the power developed by the engines.

Since the airplane performance would depend upon which of the several power lift systems were used, let's concern ourselves only with the effect of the lift coefficient without regard to how it is obtained. This of course does not then evaluate the merits of the several systems from an economical and operational point of view.

Since any study of this kind should be of a rather limited scope, the following ground rules have been used:

1. The transport aircraft used had an aspect ratio of 7. It was equipped with full-span high-lift devices and was assumed to have a wing efficiency factor of 0.8.
2. The wing loading and payload were assumed to remain constant for increases in thrust/weight ratio, thus making the gross weight and airplane size change with changes in T/W.
3. During the ground run an average deceleration of 7 ft per sec per sec was used.

Landing Improvements

It is the opinion of many engineers that the major effort should be applied to improvement of landing characteristics — both for now and for the future. In order to get an overall picture of how some of the airplane variables affect the landing field length, Fig. 1 has been prepared. The field lengths were estimated using the following approximate equation from page 199 of "Airplane Performance Stability and Control" by C. D. Perkins and R. E. Hoge:

$$\text{Field length} = \frac{1}{0.6}\left(\frac{118\ W/S}{C_{L_{max}}} + 400\right)$$

It is evident that if the wing loadings are going to increase in the future as they have in the past, something drastic must be done if runways are to be kept at reasonable lengths.

Aircraft

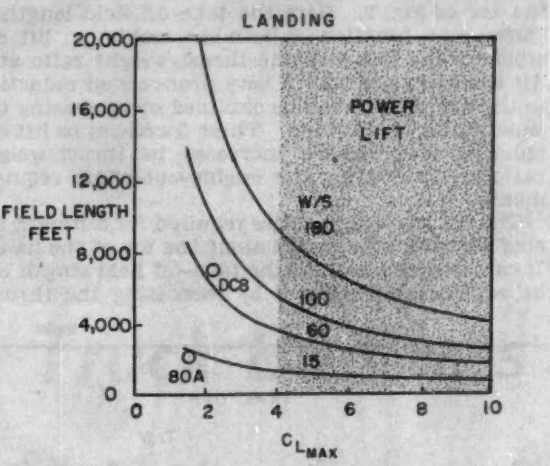

Fig. 1 — Landing field length requirements decrease sharply as maximum coefficient of lift increases and as wing loading decreases.

Spotted on this figure are the estimated values of field length for the Boeing 80-A transport which was put into operation by United Air Lines in 1929 and for the Douglas DC-8 transport which United plans to put in operation in 1959, just 30 years after it started using the 80-A. The most obvious differences in these two airplanes from the landing performance viewpoint are the large differences in field length and wing loading with only a small difference in $C_{L_{max}}$. Landing field lengths can be reduced by decreasing the wing loading or increasing the lift coefficient. But since high wing loadings are almost synonymous with long-range high-speed transports, the emphasis should be put on increasing the lift coefficient.

The shaded portion of the figure represents the lift coefficient range where power must be used to obtain the lift. The dividing line between aerodynamic lift and power lift is very optimistic, since a value of $C_{L_{max}}$ of between 3 and 4 is about all that can be foreseen by the use of trailing-edge flaps of large chord and leading-edge flaps, slats, or slots even with boundary-layer control.

Much can be accomplished without the use of power lift by utilizing the most efficient full-span high-lift devices. For example, increasing the maximum lift coefficient from about 2 (the values associated with the new jet transports) to a value of about 4 would reduce the field length by a factor of 2. If, however, even shorter field lengths are required or wing loadings are increased, then resort to some form of power lift would seem mandatory. Which of the several forms of power lift will be used will depend on the particular airplane and its mission and on the research now being conducted. The schemes that seem applicable at this time are the tilt-wing arrangements, the tilting jet or propeller, the deflected slipstream, the jet flap, or a combination of one or more of them. All of these schemes are capable of vertical take-off and landing with sufficient installed thrust.

Reductions in field length can also be obtained by the use of drag-producing devices such as speed brakes, spoilers, and thrust reversers to reduce the ground roll. But their usefulness is limited by the decelerations that can be tolerated by the passengers and by the maximum approach speed that is consistent with safe landings particularly in limited visibility.

Approach Phase

In addition to field-length requirements, the approach phase of the landing presents very important problems that must be solved to substantially improve the landing performance of a transport aircraft. The new jet aircraft without the drag-producing propellers would seem to need some sort of glide-path control to assure satisfactory approaches to the runway. It would seem advisable that this glide-path control should be considered in the design of the high-lift system to be used since in this manner additional moving surfaces, and consequently weight, might be reduced.

During landings with limited visibility, we are confronted with the problem sometimes referred to as "the last 200 ft." One approach to the problem is to provide the pilot with a completely automatic system that can function as well as the pilot can under conditions of unlimited visibility. It does not appear necessary to provide the airplane with more stability and control for this automatic system if the pilot, when he can see the airport during the approach, can make satisfactory approaches and touchdowns. The problem then is to give the automatic device sufficient intelligence so that it can perform the task in a manner very similar to the human pilot.

Another approach to the problem, and in addition very probably a necessary part of the automatic system, would be a display that would allow the pilot to see where he is in relation to the runway, both as to position and height.

One of the reasons why many people believe that the take-off problem is less serious than the landing

problem for aircraft of the future is illustrated by the use of Fig. 2. Here the take-off field length is shown as a function of both the maximum lift coefficient and the airplane thrust/weight ratio at a lift coefficient of 2.2. A very pronounced reduction in the field length can be obtained by increasing the capabilities of the wing. These increases in lift coefficient also require increases in thrust/weight ratio as dictated by the engine-out-climb requirements.

The thrust/weight ratios required for different lift coefficients are indicated along the top of the figure. It can also be seen that the take-off field length can be considerably reduced by increasing the thrust/weight ratio while maintaining a constant lift coefficient. These results (the dashed curve) may be somewhat on the optimistic side since the acceleration-stop distance, which will have its most adverse effect at the higher thrust/weight ratios, has not been considered.

For comparison the landing length is presented as a function of lift coefficient for the same airplane accounting for the fuel burned during cruise. It can be seen that the landing field length is greater than the take-off field length at the higher values of lift coefficient presented. It is interesting to note, however, that if the lift coefficient is maintained at 2.2 and the thrust/weight ratio increased proportionally to that required for a given $C_{L_{max}}$, the take-off field length is only slightly greater than the landing field length. Since some people believe that the use of power to obtain lift during take-off is not palatable, they can obtain take-off field lengths very close to the landing field lengths by merely increasing the thrust/weight ratio.

To obtain some idea as to how the ground run during take-off varies with lift coefficient, Fig. 3 has been prepared. We see as in the landing case that increases in lift coefficient or reductions in wing loading can result in large decreases in the ground run. It is also quite obvious if the future supersonic transports are to have take-off wing loadings in the order of 180 psf or greater, something must be done to increase the maximum lift coefficient. The ground runs presented here were obtained by the following equation:

$$\text{Ground run} = \tfrac{1}{2}\int_0^{V_2} \frac{d(V)^2}{\text{acceleration}}$$

This figure also presents the thrust/weight ratio required to satisfy climb requirements for the different maximum lift coefficients.

In general, the take-off picture indicates that reductions in take-off distance at a given wing loading may be obtained by increasing the thrust/weight ratio at a given lift coefficient or by increasing the maximum lift coefficient and the thrust/weight ratio. Any attempt to obtain this reduction by reducing the useful load (fuel and payload) to reduce the wing loading and increase the thrust/weight ratio soon finds the airplane without either payload or range. The method used would of course depend upon the thrust/weight ratio required for cruise and the field length limitations since a given field length as indicated in Fig. 2 can be used with considerably less power by increasing the maximum lift capabilities of the wing than by increasing the thrust/weight ratio alone.

Some penalty must be paid for short take-off and landing capabilities to allow for the additional power required, which cannot always beneficially be used during normal cruising flight. It is conceivable that with improvements in the state of the art, powerplants may be provided with greater flexibility in operating characteristics and with sufficient lightness so that the penalty for short take-off and landings may be reduced. The question then is: Can we afford the added safety and convenience of shorter field lengths? Or perhaps the question is: Can we afford not to reduce the airplane's minimum speed, thus reducing the field length and increasing the safety level during take-offs and landings?

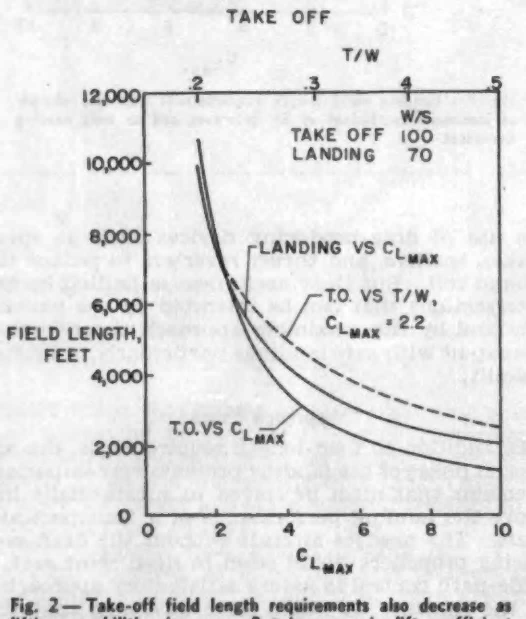

Fig. 2 — Take-off field length requirements also decrease as lifting capabilities improve. But increases in lift coefficient entail increases in thrust/weight ratio because of engine-out climb requirements.

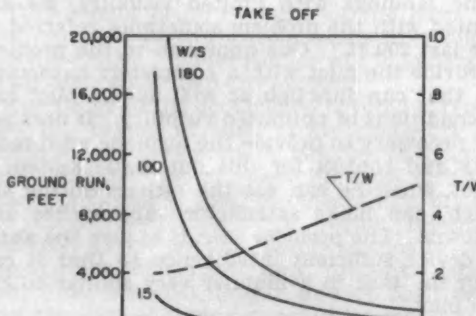

Fig. 3 — Increases in lift coefficient or reductions in wing loading decrease length of ground run preceding take-off.

Questions on air suspension

to door handles get answered when

Operators Probe Truck Builders

Based on secretary's report by

G. H. Maxwell

Hertz Corp.

Question: Is braking being improved as the gross/empty weight ratio goes up?

Answer: Smooth stops for unloaded trucks can be achieved by a longer travel in the treadle valve, giving the driver a better feel of the brakes, or using air suspension with a proportioning valve that supplies air pressure to the brakes in direct proportion to the load.

Question: What are the advantages of dual front axles?

Answer: Increased payloads are possible. For the addition of approximately 1500 lb in vehicle weight, gross vehicle weight rating can jump as high as 15,000 lb.

Question: Will American manufacturers meet the challenge of small European trucks?

Answer: The small U.S. car will have to come first. Once a small engine, chassis, and other parts have been tooled up, the production of a small commercial body may be financially possible. To date, small trucks have been imported from European subsidiaries.

Question: Can spring shackles be designed to hold more grease?

Answer: A greater grease reservoir does not solve the contamination problem. Periodic pressure lubrication is needed to flush out the foreign materials that collect from the road. The flush should be done in an unloaded spring condition. High priced rubber load-carrying bushings would solve the periodic lubrication problem.

Question: Why use pleasure car hardware on commercial vehicles?

Answer: Price! However, life expectancy of some items is: door handles—300,000 cycles; window

THIS ARTICLE is based on a panel meeting where "Consumer Fleet Maintenance Problems Were Handed to the Manufacturer." O. A. Brouer, Swift & Co., was Chairman; R. R. Faller, Ethyl Corp., panel moderator; and G. H. Maxwell, Hertz Corp., secretary.

Members of the panel were:

Users—

F. O. Terrill, Kroger Co.

R. K. Reese, Kraft Foods Co.

R. W. Thomas, Quality Bakers of America Co-op, Inc.

Julius Gaussoin, Silver Eagle Co.

D. J. Seigel, Hertz Corp.

Manufacturers—

D. W. Lee, Ford Motor Co.

J. H. Letsinger, International Harvester Co.

D. L. Harbaugh, Lee Rubber and Tire Corp.

R. L. Hardin, Trailmobile, Inc.

E. D. Hendrickson, Hendrickson Mfg. Co.

regulators—200,000 cycles; light switches—500,000 cycles. Although tougher seats are supplied with heavy-duty vehicles, specially developed seats are also available.

Question: What is the future of trailer air suspension?

Answer: Maintenance costs will be equal to or less than those for springs in the near future. Operators will have to decide if the additional dollars of original cost are worth the advantages of an air ride.

Question: Have plastics gained in trailer usage?

Answer: Yes—for applications such as skylights, bushings, insulators, and name plates.

No—for structural members. Cost has controlled this area.

Question: When will engineers take back light vehicle design from stylists?

Answer: Management has control of overall design, and engineers and stylists follow its lead. To bring the fleet operator an economical light truck, the mass market has to be considered.

Question: Are manufacturers interested in operator's experience?

Answer: Yes!!! For example, a "guaranteed maintenance cost" program has recently stimulated an IBM breakdown of failures in three fleets totaling 215 vehicles and 39,438,549 miles. Failure codes were set up for 276 specific items to evaluate the running costs of the operations. Information is fed to the designers so they can pinpoint and correct the trouble spots. Some of the maintenance cost comparisons found are:

- Windshield wipers are equal to all of the instruments.
- The electrical system is twice the sum of the propeller shaft, springs, steering gear, wheels, and transmission.
- The battery is equal to the generator and each cost twice as much as the starter.
- The total of the battery, generator, and starter is equal to the cylinder head and valves.
- The generator is equal to the sheet metal, including the body, cab, and cowl.
- The total fuel system is equal to the engine cylinder head, valves, piston rings, and bearings—or the rear-axle carrier assembly.
- Front-wheel bearings are equal to the front axle, exclusive of brakes and wheels.
- Brakes are twice the clutch.
- The cooling system is the same as the rear-axle carrier assembly.
- Heaters are equal to propeller shafts.
- Mufflers and exhaust pipe are twice the transmission.

Better Avgas

Based on paper by

Frederick P. Glazier

Wright Aeronautical Division, Curtiss-Wright Corp.

(Presented at the SAE Metropolitan Section)

In a 150-hr test in a fuel-injection R-3350 engine, AK-33X at a 0.2 gram metal per gal concentration raised detonation limits without serious side effects. Actual results obtained with the use of this antidetonant, identified as methyl-cycle-pentadienyl-manganese-tricarbonyl, are shown in Fig. 1, which illustrates the relative knock-limited horsepower of different concentrations in combination with the normal concentration of aviation-mix in the full-scale engine.

The improvement in engine performance is shown in still another way by Fig. 2. Here is shown the percentage increase in knock-limited horsepower at the various test conditions, the rpm being selected to simulate airplane take-off, climb, and cruise conditions.

Tests were also run in a single-cylinder engine to evaluate the relative performance of several concentrations of AK-33X in 115/145 base stock and in leaded 115/145 gasoline. These tests revealed the following facts:

- It is possible to get as much response from straight AK-33X in the gasoline as can be had from adding tel.
- The addition of AK-33X to aviation-mix in aviation gasoline achieves more response for the total amount of additive in the fuel than it is possible to get from tel alone.
- The use of AK-33X in addition to aviation-mix in the fuel increases the engine performance number of the fuel considerably without critically affecting the "tolerability" of the fuel.

Drawbacks of AK-33X

The limited testing done thus far shows more spark-plug fouling to occur under low power conditions with AK-33X in the fuel, while at high power conditions there is no increase in fouling. While

. . . **a strong probability. AK-33X additive, a qualified success under test, gives promise of improved piston-engine performance.**

no attempt has been made as yet to develop an engine burn-out procedure to alleviate fouling, the single-cylinder test with avgas containing the antidetonant indicates that such fouling can be greatly minimized with proper selection of ignition components.

Also noted was an increase in exhaust valve stem and/or valve guide wear. The 150-hr test verified this deleterious effect as well as the spark-plug fouling, and it pointed out in addition that:

1. When heavy guide or stem wear occurs, valve failures can be expected and heavy seat wear may occur.

2. Combustion chamber deposits were heavier than normal in localized areas such as intake valve domes and exhaust valve throats, but apparently without detrimental effects on engine operation.

3. Exhaust system and power recovery turbine deposits were also heavier than normal, but easily removed by light dusting.

It is anticipated that both spark-plug fouling and valve stem or guide wear are possible to overcome.

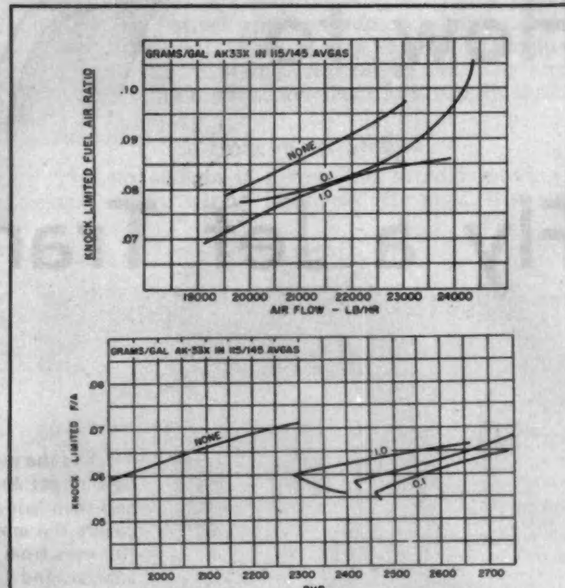

Fig. 1 — Relative knock-limited horsepower of various concentrations of AK-33X in combination with the normal concentration of aviation-mix in an R-3350 engine: (upper) at 2900 rpm, (lower) at 2500 rpm.

Summary of Good Points

AK-33X causes no significant increase in metallic corrosion in fuel alone, in the water space below the fuel, or at the fuel-water interface. It does not affect the principal sealants being used in aircraft. Since the final, recommended AK-33X concentration is unknown, all corrosion studies have been made with a concentration of 1.0 gram metal per gal above the usual tel content. This was done with the understanding that the final concentration would be under this amount, and use of a greater test concentration should result in data having a margin of safety. Work is now being done to determine the compatibility of AK-33X with every type of material with which it or its exhaust products would come in contact.

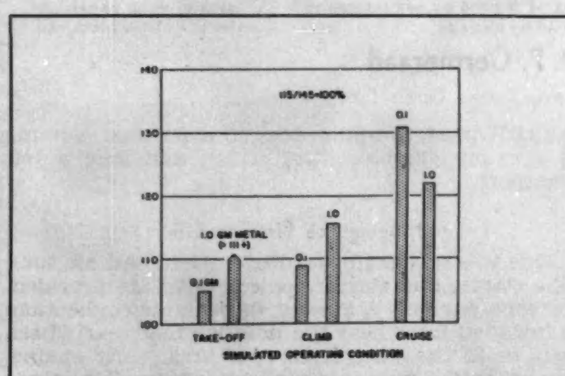

Fig. 2 — Percentage increase in knock-limited horsepower at 2900, 2600, and 2500 rpm test conditions, selected to simulate airplane take-off, climb, and cruise operating conditions.

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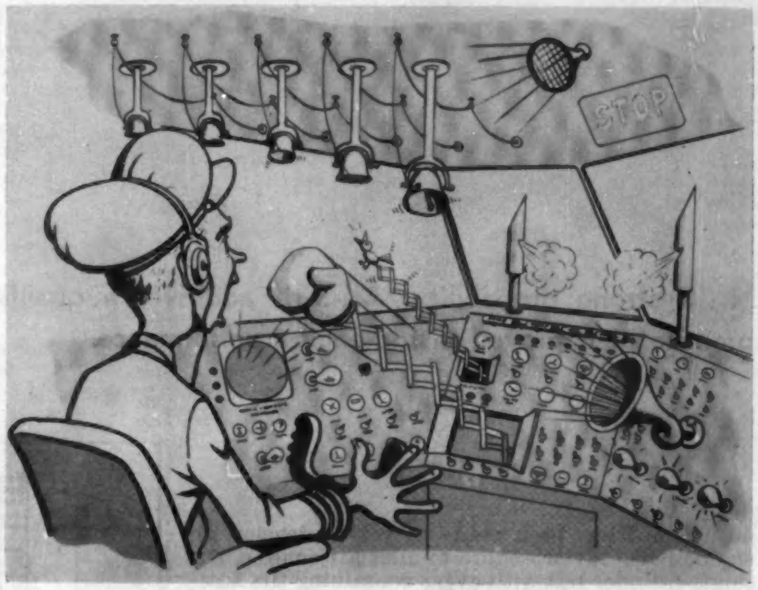
. . . on which this article is based, turn to page 5.



How to Fly a Jet Transport

THIS is the inside story of piloting a commercial jet transport. It tells you how to get the aircraft off the ground and into the air, to cruise around, and then bring it down again all in one piece. In his paper, the author also covers the more rugged aspects of transport flying, the ones that separate the men from the boys. He tells how to handle emergencies on take-off, analyze and control in-flight troubles, evacuate smoke, make emergency descents, and ditch in open water.

Based on paper by

D. P. Germeraad

Convair Division, General Dynamics Corp.

HERE'S what the pilot does to start, taxi, runup, take-off, climb, control cruise, and land a jet transport.

Bringing the Birds to Life

This is a straightforward operation. An air turbine starter and starter control valve are provided for each engine. A ground starting air connection is installed in or near the nose landing gear wheel well, or in the wing front spar area. Any engine can be started from this pneumatic source. A cross-over engine bleed system enables starting of the other engines once the initial engine is operating. This is shown in Fig. 1. All four engines can be brought to ground idle speed within 150 sec. Simultaneous engine starting can reduce this time by 50% on some turbine-powered aircraft. Time is of the essence in quick turn-arounds.

Assuming pneumatic, electrical, and fuel systems to be in readiness, there follow eight specific cockpit motions. These are:

1. Place power control lever in "idle" position.
2. Move fuel shutoff lever from "off" to "start." This will open the fuel shutoff valve and close one of two series switches to the ignition system.
3. Operate the start switch and hold in the "ground start" position. The start switch will activate relays, which will supply power to operate the starter air control valve and will energize the ignition system.
4. Monitor engine speed and exhaust gas temperature while the engine is brought up automatically to firing rpm, fired, and accelerated through

starter cutout speed to an idle speed. At starter cutout speed the starter cutout switch will de-energize the starter air control valve and ignition system. Release start switch when the starter cut-out rpm is reached. It will return automatically to the "off" position.

5. Move fuel shutoff lever from "start" to "run" position. This opens the ignition switch.

6. Move power control lever forward to get 80% engine speed on the engine started first to provide sufficient air for starting the remaining engines. Subsequently, started engines may remain at idle power.

7. The start can be aborted by moving the fuel shutoff lever to "off" position and releasing start switch from "ground start" position. The fuel shut-off valve will be closed, the ignition de-energized, and the starter air control valve turned off by such action.

8. The engine can be rotated without the application of ignition or fuel by operating the start switch to the "ground start" position.

Taxiing to Runway

Time and clearance should be coordinated with Airway Traffic Control prior to engine start if any take-off delay is expected. Once engines have been started, taxi immediately to service runway and avoid stopping at intersections on the way. It will take more power and fuel to get rolling again.

Normally, the aircraft will leave the ramp with a fuel loading in excess of the maximum allowable take-off gross weight because of the turbine engine's greater fuel consumption rate on the ground. The excess will equal the fuel burn-off required for normal taxi and runup. Actual take-off will not be permitted above the maximum allowable gross weight figure.

Runup and Take-off

The best way to complete engine runup and take-off is to taxi straight to take-off position on the duty runway, traffic permitting. Make sure the nose wheel is aligned with the runway and not cocked to one side. Set take-off power on all engines, then check oil, fuel, exhaust gas temperature, pressure ratio, and rpm for proper readings. When you are satisfied with all indications, release brakes and start the take-off roll. Detailed cockpit check list items will have been completed during the preceding three operations. Normal take-off calls for acceleration to within 5 knots of V_2 speed — the minimum take-off safety speed — with all wheels on the runway, then rotate the aircraft climbing out at V_2.

Climb and Cruise Control

A cruise climb or driftup climb is the most efficient for jets, as shown in Fig. 2. It takes full advantage of fuel burn-off. However, the procedure will complicate existing airway traffic control systems. Altitude conflicts with other aircraft mean an altitude stepup or stepdown or staying at an assigned altitude. Any one of these represents a deviation from the optimum, with subsequent marked effect on fuel consumption. Deviations from the planned course also will decrease the amount of fuel reserve over the destination unless a wind advantage materializes.

Domestic civil jets seldom will be able to use driftup techniques, but must fly an assigned constant cruise altitude or a step-climb schedule. Accurate navigation and efficient use of radar may ease this problem. Constant altitude cruise data are developed from the basic relationship between specific fuel consumption (nautical miles per pound of fuel) and aircraft airspeed (Fig. 3). Cruise control for best range is gained by reducing thrust and airspeed as fuel is consumed and aircraft weight decreases. If Airway Traffic Control permits, the optimum range can be gained by flying a cruise-climb flight path, as shown in Fig. 4. Stabilize at a constant Mach number and allow the aircraft to climb slowly as the weight decreases.

Fuel management techniques in flight on turbine-powered aircraft are quite simple. Once the fuel system feed valves and fuel pump controls are positioned for flight, little if any further attention is required. The system is flexible so that any engine can be supplied with fuel from any supply tank.

Flying in Jet Streams

The jet stream is a random, rapidly moving air mass which winds aimlessly through the upper

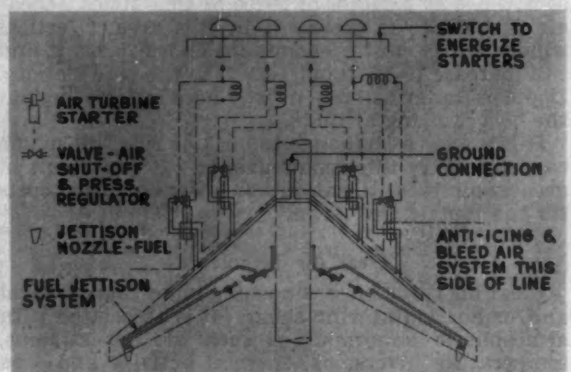


Fig. 1—Engine starting system on jet transport. After the first engine to be started is in operation, a cross-over engine bleed system permits starting of other engines. All four engines can be brought to ground idle speed within 150 sec.

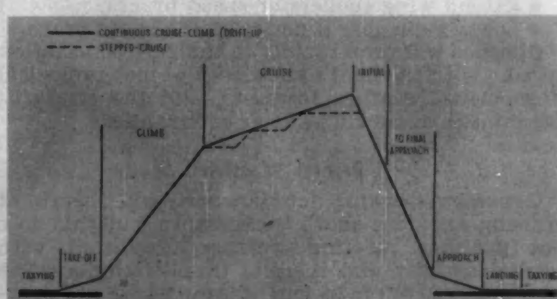


Fig. 2—Flight-path diagram shows that driftup climb is most efficient, but stepup climb may have to be used because of conflicts in altitude with other aircraft. Driftup climb takes full advantage of fuel burn-off.

How to Fly a Jet Transport

continued

atmosphere, dipping down at times to 15,000 ft. Wind velocities in the heart of these streams may easily reach 150 knots (Fig. 5). Fantastic figures more than double this have been reported. This meteorological phenomenon can be a terrific asset or a drastic liability. Advance knowledge or in-flight location of the jet core, gained by Doppler-Radar and inertial navigation equipment, can mean important time and fuel savings to a pilot, whether it be a boost from a tailwind component or evading one on the nose by circumnavigation or changing altitude.

Accurate forecasting is a must. Some streams lose their punch rapidly or take off on a new tack. Alert forecasters may sometimes spot the vagaries of the culprit by analyzing pressure trends and thus forewarn the flight crew.

Best use of jet stream depends on a thorough understanding of the horizontal and vertical shear which is an integral part of its complex make-up (Fig. 6). Horizontal wind shear is always greater toward the cold air to the north of the jet core, sometimes by a factor of three or four times. Clear air turbulence is prevalent in this area. Vertical wind shear is most predominant above 25,000 ft and can increase 10–20 knots/1000 ft in the core vicinity. Doppler-Radar will pay its way here in ferreting out the best cruising altitude.

It is always a challenge to buck or ride this magic carpet and try to outmaneuver it. It can result in greater aircraft utilization and lower operating costs for the route-miles flown.

Clear Air Turbulence

Clear air turbulence is nothing more than vertical and/or horizontal wind shear. It is associated with atmospheric abnormalities such as: jet streams, temperature inversions, thermal activity and — as two West Coast airline stewardesses will tell you — strong air currents in the lee of mountain ranges. When clear air turbulence strikes unexpectedly, as it does, aircraft deceleration procedures are at the pilot's command. These are:

- Reduce engine thrust.
- Extend wing spoilers or speed brakes.
- Lower main gear if designed as a speed brake.

Airspeed will drop rapidly to the gust penetration speed. With the pilot's knowledge of meteorological phenomena, weather forecasts, and the aircraft's capabilities, it should be clear sailing ahead.

Frontal Weather

Generally speaking, jet transports will operate at cruising altitudes above the weather, but this does not preclude meeting weather associated with frontal activity and thermal thunderstorms. The tops reach 50,000 ft in some cases. These are occasions for using airborne radar. Reduce airspeed to aircraft gust penetration speed. Weave between the storm cells to avoid severe turbulent areas. Judicious use of radar will improve passenger comfort and reduce airframe structural loads.

De-icing and anti-icing procedures will be comparable to those used with piston-engine aircraft while operating in terminal areas. However, because of the increased dynamic heating at higher speed, the most likely air temperature for airframe icing at cruise is lower (about −15 C) for jets as compared to −8 C for piston-engine aircraft. Engine thrust will be unaffected by rain, snow, or hail except when using air-bleed for de-icing. In the latter case, thrust can be readjusted to normal values with some increase in fuel flow.

Weather radar is worth its weight in U-235 and its use cannot be overstressed. Fig. 7 illustrates the circumnavigation of severe turbulence and moderate icing on a flight from Gander to Keflavik by use of the electronic eye.

Landing a Jet Transport

ILS approach speeds will be 10–20 knots higher for the jets. Therefore:

1. The glide path slope should be 2.5 deg or less.
2. Greater radiation stability and tightening of the present ILS glide path tolerance is desired. Only then can the automatic approach coupler do its job effectively without porpoising.
3. There should be a standard geographical position for the middle marker.

The pilot has approximately 20 sec on a precision instrument landing to:

1. Change from instrument to visual flight at time of breakout.
2. Appraise the situation.
3. React, taking any corrective action necessary such as dissipating excess speed, correcting for cross-wind.
4. Flaring for touchdown.

Hold aircraft at the recommended speeds to runway touchdown. Excessive speed and/or holding the aircraft off the runway will "eat" runway at a voracious rate. Approximately 200 ft of runway passes with each additional second at these speeds. Pilot aids such as "angle of attack" and and "coefficient of lift" indicators are beneficial.

Reverse thrust is a requisite for all jet transports to:

1. Provide adequate deceleration when wheel brakes are ineffectual, for example, on wet asphaltic concrete, icy runways, and the like.
2. Compensate for pilot landing inconsistencies.

The longest runways will be used on hot days because of the high density altitude and resultant loss of performance. When an airport has just one long runway it may entail increased operations in cross-wind conditions. A jet must take a 30-mph direct cross-wind in its stride. Sensitivity to cross-winds is more pronounced with swept wing designs. Aerodynamic forces tend to roll the airplane toward the lee side. This is further aggravated by the narrower tread landing gear. Compensation has been more than provided for by the installation of a more responsive lateral control system using differential wing spoilers.

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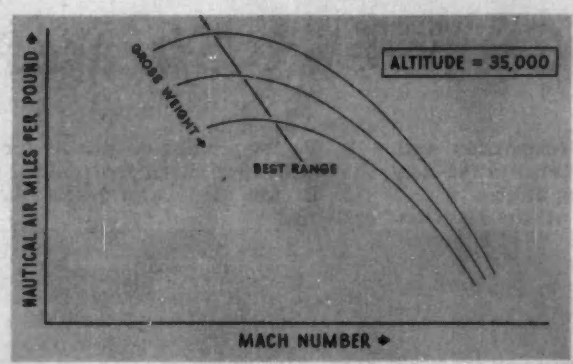

Fig. 3 — Constant-altitude cruise data are developed from the basic relationship between specific fuel consumption (nautical miles per pound of fuel) and the aircraft airspeed.

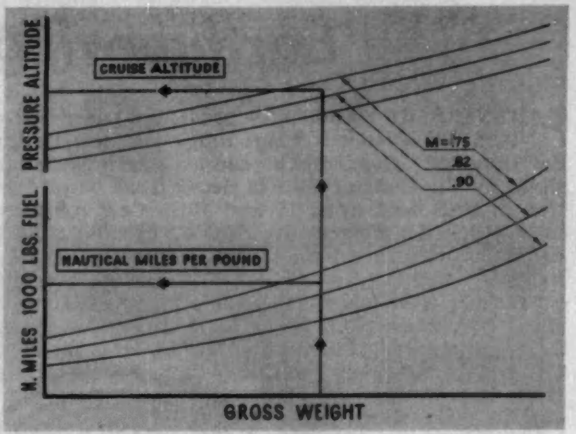

Fig. 4 — Optimum range can be achieved by flying a cruise-climb flight path, assuming that it is permitted by Airway Traffic Control. Stabilize at a constant Mach number and allow the transport to climb slowly as weight decreases.

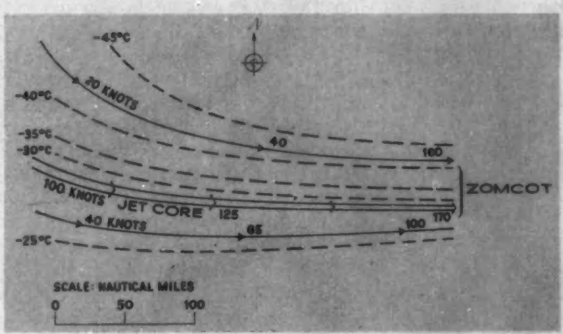

Fig. 5 — Polar jet stream at 20,000 ft. Mighty jet streams are caused by confluence of cold and warm air masses. Wind velocities in the heart of a stream may reach 150 knots, and much higher have been reported. Riding an air stream pays dividends.

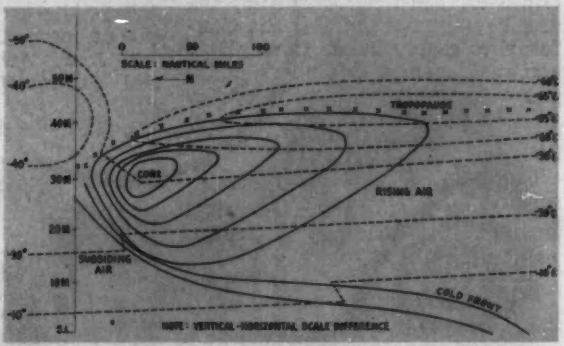

Fig. 6 — Vertical cross-section of polar jet stream shows that horizontal wind shear is always greater toward the cold air to the north of the jet core. Clear air turbulence is prevalent in this area. Vertical wind shear is most predominant above 25,000 ft and can increase 10-20 knots/1000 ft in the core vicinity.

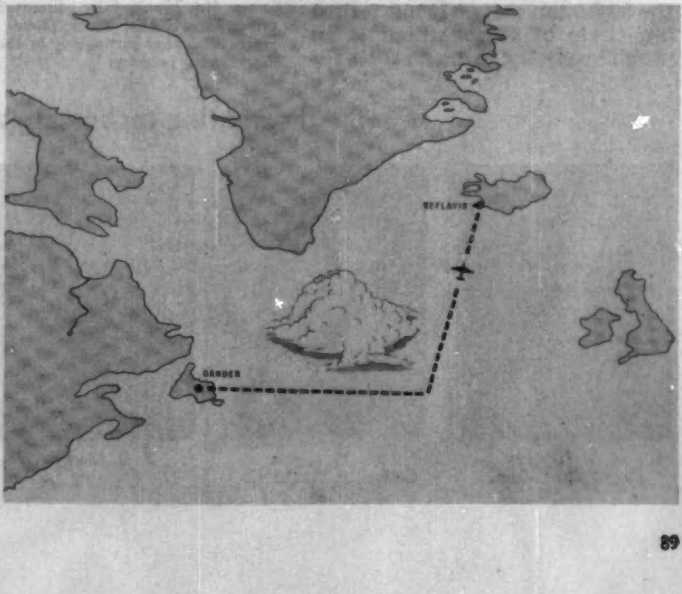

Fig. 7 — Dodging storm cells and thus avoiding severe turbulence is the job for radar. It saves passengers discomfort and reduces airframe structural loads.

Earthmoving Conference Stresses

PARTNERS IN PROGRESS provided the theme for the 1958 Earthmoving Conference sponsored by the Central Illinois Section of SAE held April 15 and 16 in Peoria, Ill. This is the Ninth Annual Conference held since its inception in 1950.

The conference opened with a short welcoming address by Karl L. Mason, general chairman of the Conference. Mason pointed out that when engineers, manufacturers' representatives, and contractors team up to produce efficient economical earthmoving machines, then they are truly "Partners in Progress."

Col. James H. Frier, consulting engineer, Emrich Consulting Co. and keynote speaker for the Conference emphasized that when contractors and engineers cooperatively apply the basic principles of a sound research and developmen program, again they are truly "Partners in Progress".

Almost 1600 SAE members and guests attended the four technical sessions to hear 10 technical papers presented.

Technical Highlights of the Meeting

LeTourneau - Westinghouse's new 32-ton rear dump truck features a wheelbase of 129 in. This is 40–50 in. shorter than rear dumps in the 22–25 ton class.

The new truck is up to 20 ft shorter than conventional single-axle rear dumps in the 22–25 ton class and up to 45 ft shorter than tandem-axle rear dump trucks in the 30–35 ton class. It has a turning circle of 43 ft, which is approximately the same as the average passenger car.

A new Hydrair suspension and steering design permits 45-deg front wheel turning angles.

One contractor at the Meeting revealed that 20% of the down-time associated with his earthmoving equipment was caused by lack of parts while 35% was due to external problems, that is, items on the outside of a machine such as sheaves, cable, hoses, and structural failures.

This contractor suggested the following improvements to earthmover manufacturers as an aid toward reducing down-time.

1. A better air filtration system to accommodate the greater air-flow required for the new higher-output engines.
2. A heavier-duty electric system to permit increased night work.
3. Fully scaled bearings in sheave assemblies.
4. Better plumbing systems for the transfer of air or hydraulics.
5. Better cable and hydraulic systems.

KEYNOTE SPEAKER at the Conference was Col. James H. Frier. Frier discussed the basic principles essential to a sound development program, slanted particularly to the man in the earthmoving industry.

The 2-engine powerplant used with off-highway equipment is at present restricted to: a 2-axle drive, and a torque converter transmission. This lack of flexibility plus the higher initial cost of two transmissions puts the 2-engine arrangement at a definite disadvantage to a single-engine system.

Lack of a compounding gear capable of connecting with a single axle makes the 2-axle drive a must. No presently available transmission is capable of providing the gear splits and transmitting the torque.

The torque-converter transmission is required because the two engines are finally compounded at the wheel-to-ground contact. The converter characteristics are such that the differences between engines, whether caused by engine condition or throttle position, can be absorbed.

The total transmission cost for a 2-engine unit in the 400-hp size is 60% greater than the comparable transmisssion for a single 400-hp engine.

Approximately 560 SAE members and guests attended the annual dinner banquet to hear Countess Maria Pulaski relate her exciting experiences as an espionage agent in World War II. Toastmaster for the occasion was George Eger, chairman of SAE Central Illinois Section.

Presenting technical papers at SAE Central Illinois Section's

E. A. Richards
Borg-Warner Corp.

M. M. Coker
Caterpillar Tractor Co.

E. O. Martinson
Koehring Co.

H. T. Peraz
Construction Methods & Equipment Magazine

R. Kress
LeTourneau-Westinghouse Co.

Engineer-Contractor Cooperation

PARTICIPANTS at Earthmoving Industry Conference: (front row, left to right) Commander H. W. Whitney, U.S. Naval Reserve; J. Gerber, Glidden Paint Co.; H. S. Eberhard, president, Caterpillar Tractor Co.; Countess Maria Pulaski, guest dinner speaker; K. L. Mason Caterpillar and chairman, 1958 Earthmoving Industry Conference; William K. Creson, 1958 SAE president; and J. W. Bridwell, Caterpillar.

Back row, left to right: A. W. Van Herke, Allis-Chalmers Mfg. Co.; John A. C. Warner, SAE secretary and general manager; Colonel J. H. Frier, Emrich Consulting Co. and keynote speaker; P. B. Benner, Caterpillar; A. Mann, Hyster Co.; E. E. Isgren, executive vice-president, Le-Tourneau-Westinghouse Co.; J. Greenlee, president, 1958 Earthmoving Manufacturers' Auxiliary; J. L. Mack, Inland Steel Co.; and G. W. Eger, Caterpillar and chairman, SAE Central Illinois Section.

9th Annual Earthmoving Industry Conference were:

S. C. Lore
U. S. Steel Corp.

K. F. Schauwecker
U. S. Steel Corp.

Com. H. W. Whitney
U. S. Naval Reserve

K. Leech
Cummins Engine Co.

D. A. Armstrong
S. J. Groves & Sons Co.

Military Defense Topics Highlight Texas Aircraft Production Meeting

THREEFOLD OBJECTIVE of our military defense system is to provide deterrent power (the power to retaliate overwhelmingly); defense capability; and the power to wage "brush fire" or localized warfare. That's what Congressman Bruce Alger told 300 or more members and guests attending the 4th Annual Aircraft Production Meeting sponsored by SAE's Texas Section.

Major-General J. P. McConnell, Commander, Second Air Force, indicated that missiles and aircraft will complement one another in this defense effort.

I. Nevin Palley, vice-president of engineering, Temco Aircraft Co., advocated a return to basic research to find defensive systems that cannot be knocked out by potential enemies.

Gifford K. Johnson, vice-president, production, Chance Vought Aircraft, Inc., told SAE'rs that equipment for the pilot is becoming more complex and more necessary in fast jets, and discussed the absence of such pilot aids as a major difference in manufacture of missiles.

Eric Jonsson, president of Texas Instruments, Inc. gave a short introductory speech of welcome.

Retaliatory Force

The Strategic Air Command, with its bomber aircraft, air refueling tankers, and worldwide network of bases, provides the principal element of our retaliatory forces, Alger revealed in his address entitled "The Military Budget and Where It's Going." In addition, overseas air units include both manned aircraft and Matador missiles capable of providing a long-range nuclear punch.

"Our Navy's carrier task forces are deployed well forward in both European and Far East waters, and constitute a nuclear striking force to be reckoned with."

Continental Defense

Our present early warning system stretches from the Mid-Pacific across the Northern edge of our continent and includes the North Atlantic approaches. In addition to the various warning lines on land, sea, and air, this system includes a complex communications and electronic control system. "Some 60 Nike-Ajax ground-to-air missile battalions are in readiness together with a system for controlling their fire."

Numerous fighter-interceptor units are active in the Continental Air Defense System, many of these with missile and rocket capability, including nuclear warhead rockets.

"The Navy operates picket ships and aircraft over the seaward extensions of the land-based radar lines and maintains anti-submarine patrol."

Brush Fires

To handle local skirmishes, Infantry division firepower has been increased tremendously.

"Other major combat units include 12 brigades, separate battle groups and regiments, and four Army missile commands." Also, "we have over 100 separate combat battalions, including many missiles and rocket battalions capable of employing nuclear warheads, and more than 20 aviation companies."

Three divisions and three air wings of the Marine Corps maintain combat readiness, supported by ground units capable of employing nuclear weapons.

Almost all of the combatant ships of the Navy have some sort of anti-submarine capability. These forces include ASW support carriers and their specially fixed and rotary-winged aircraft, land-based anti-submarine patrol aircraft and air ships, destroyers and patrol vessels, and a sizable number of hunter-killer anti-sub submarines.

Anti-submarine weapons include acoustic-homing torpedoes, atomic depth charges, and other devices.

Room for Both Airplanes and Missiles

The airplane and the missile will complement one another long into the foreseeable future, Major General J. P. McConnell, Commander, Second Air Force, told SAE members at the meeting.

"Despite efforts to accelerate the integration of missiles, it is difficult to determine how much time it will take," said McConnell. "Therefore, since we must not take any chances where maintaining our deterrent strength is concerned, we must continue to modernize our manned bombers and at the same time devote every possible effort to the rapid buildup of a reliable strategic missile force."

"While missiles will certainly have an increasingly important role in strategic warfare, the transition from an all-bomber to a mixed-missile-bomber force must be accomplished in an orderly fashion so that there will be no gaps in SAC's strength to deter Communist amibitions. And, barring the possibility of a major technological breakthrough that could make both the plane and the missile obsolete, there will continue to be certain jobs in which manned aircraft will be more effective."

On the other hand, "it would be tragic to underestimate the present or potential capabilities of the strategic missile. Its quick reaction time and virtual immunity to the effects of bad weather are enough to justify whatever expenditures of time and money are

required to develop them to full operational capabilities."

Wants Missile Program Revised

Additional investment and technical effort associated with defense weapons which are dependent on electronic aids and which are to be used for area type defense should be minimized, suggested I. Nevin Palley, vice president of engineering, Temco Aircraft Corp. in his address entitled "Missiles — Their Place Today and in the Future."

Instead, we should prosecute vigorously, with greatly increased funds, basic and applied research in physical sciences towards non-electronic approaches to defense weapon systems, advocated Palley.

Palley called for accelerated development of ICBM weapons but suggested that we restrict ourselves to one ICBM and one IRBM, terminating other duplicating projects.

Also, Palley suggested that we proceed with development of two-stage offensive weapons, utilizing missiles launched from submarines and manned aircraft.

Greater Automaticity for Aircraft

Increased use of automatic equipment can be expected in the aircraft of today and tomorrow, revealed Gifford K. Johnson, vice-president, production, Chance Vought Aircraft, Inc.

"The differences in aircraft and missiles systems are disappearing," Johnson said. "We are moving to more complex aircraft weapons systems and to the need for more automatic equipment to perform functions a pilot could not respond to in the time he has to react."

"In this developing age of astronautics," Johnson said, "space craft and contemporary craft are manned missiles . . . compromises are made to provide for the pilot in an aircraft — for creature comfort, for control from a central point (cockpit), for safety devices, for landing, and for escape."

"These elements are not necessarily present in a missile. But in our weapons system management the human pilot must be provided for."

Special mention is due Lee Livingston, chairman, SAE Texas Section and W. M. Bludworth, general chairman of the Meeting for the part they played in making this such a successful meeting.

GUEST SPEAKERS at SAE's Texas Section Aircraft Production Meeting. From left to right: G. K. Johnson, vice-president, production, Chance Vought Aircraft, Inc.; I. N. Palley, vice-president, engineering, Temco Aircraft Co.; Bruce Alger, United States Congressman, Fifth Congressional District.

L. P. Livingston, chairman, SAE Texas Section (left), W. M. Bludworth, general chairman of the Meeting, and Eric Jonsson, president, Texas Instruments, Inc., get together before the meeting. Jonsson gave the introductory speech at the meeting.

GUEST SPEAKER Maj.-Gen. J. P. McConnell, commander, Second Air Force, described SAC's role in our military defense program.

Rambling . . .

THROUGH THE SECTIONS

ONE POUND ADDED

to the weight of a nuclear submarine powerplant, means five to seven pounds must be added to the overall ship-weight to keep balance and displacement under control. **In addition,** if the center of gravity of the plant is moved one foot, the diameter of the hull must be increased about two feet in order to keep stability. (John L. Helm, General Dynamic's Electric Boat Division at **SOUTHERN NEW ENGLAND** in April.) . . .

Surprisingly enough, total money spent on nuclear power projects for marine application breaks down to approximately 11% on physics; 28% on mechanical engineering; 11% on electrical; 38% on metallurgical; 7% on chemical. The remainder goes to operational engineering and testing . . . thus relatively minor are nuclear aspects. Most **time** goes toward applying old engineering principles to new problems.

• • •

4¼ million cars will be scrapped this year, and 2¼ million more people will buy cars . . . thus the 1958 new car market **should** reach the grand total of 6½ million — if this year turns out to be average. **But,** whether it will or not is still anybody's guess, Chrysler's E. C. Quinn told **DETROIT SECTION** April 21 . . .

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A complete revolution over "cube" has occurred in the trucking industry stated IHC's W. E. Petersen, because operators have found their loads lighter and bulkier, while finding cargo space used-up before legal weight limits are reached. **(NEW ENGLAND SECTION,** April 1.)

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An aircraft-towing tractor, devised by SAE member Bruce Hanna, was one of the products displayed to the **COLORADO SECTION** in March. Manufactured by American Coleman Co., the device has a spool-valve rear wheel steering control . . . the tractor keeps a straight-ahead position when the control is released.

Your chances for survival in a head-on collision are about the same whether your car is a unit-body or a frame-structure. It's the lapbelt and the car's uncluttered interior that may save you . . . according to D. M. Severy at **NORTHERN CALIFORNIA SECTION** in April.

The Section's **SOUTH BAY DIVISION,** in April, heard Solar's P. W. Pichel tell of a 55-hp Titan engine for propulsion of one-man helicopters, and a 100-hp Saturn engine for marine propulsion — both now under construction at Solar.

Editorial . . .
(From Central Illinois Section Newsletter)

Xvxn though our typxwritxr is an old modxl, it works quitx wxll, xxcxpt for onx of thx kxys. Wx havx wishxd many timxs that it workxd pxrfxctly. It is trux that thxrx arx 46 kxys that function wxll xnough, but just onx kxy not working makxs thx diffxrxncx.

Somxtimxs it sxxms to mx that our Sxction is somxwhat likx our typxwritxr — not all thx mxmbxrs arx working propxrly.

You may say to yoursxlf, "Wxll, I am only onx pxrson, I won't makx or brxak thx Sxction." But it doxs makx a diffxrxncx, bxcausx thx Sxction, to bx xffxctivx nxxds thx activx participation of xvxry mxmbxr.

So, thx nxxt timx you think you arx only onx pxrson, and that your xfforts arx not nxxdxd, rxmxmbxr our typxwritxr, and say to yoursxlf, "I am a kxy pxrson in thx Sxction, and I AM nxxdxd for thx sucxssful functioning and growth of thx Cxntral Illinois Sxction, and I WILL participatx in Sxction activitixs.

(Anonymous)

Ways to get non-member interest in SAE were aired at a recent brainstorming session of the SAE Membership Committee. Many SAE Sections contributed by detailing their various procedures. Among those touted as most effective were:

- 20 tickets sent to each member before meetings, with a request that he contact and bring interested associates and friends. **(SAN DIEGO)**
- Those meetings featuring an especially outstanding speaker are tabbed "For Members Only." Interested non-members begin to ask about how they can get on the "inside." **(MID-MICHIGAN)**
- National meeting registration cards are scanned for non-members, separated and listed in Section territories, and passed on to the respective Sections for follow-up. **(NORTHWEST)**
- Following attendance at a meeting, guests are sent a personal letter noting their interest. Copies are sent to company representative and the member who invited the guest. If the guest attends more than one meeting, the second personal letter encourages him to find out about membership. **(DETROIT)**

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M. E. Ensor, **BALTIMORE SECTION** chairman (left), introduced Speaker John S. Wintringham at the March 13 meeting. The Ethyl research advisor spoke on automotive fuels.

National and local road building programs were discussed April 17 at the **TWIN CITY SECTION** by panel members, left to right, Ira E. Taylor, U. S. Bureau of Public Roads; Walter Schultz, Minnesota Highway Department; Gene S. Hart, Letourneau-Westinghouse Co.; and A. C. Overbee, U. S. Bureau of Public Roads.

Also present was SAE President W. K. Creson, who spoke on SAE growth and progress through the years.

Why, how and where to put your money was discussed by two representatives from Eaton & Howard, Inc., an investment firm which handles mutual investment funds . . . at the April meeting of **MID-MICHIGAN SECTION.**

Discussing economic problems before the meeting are, left to right: H. T. Daunt, Chevrolet Motor Division; Karl Schwartzwalder, AC Spark Plug Division; P. B. Zeigler, Section chairman; and H. D. Wright, AC Spark Plug.

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R. E. McAfee, right, shows a cutaway of IHC's Selec-o-Matic transmission, and explains its operation before presenting a paper on "Modern Truck Transmissions" at **TEXAS GULF COAST SECTION'S** March meeting. The speaker is project engineer in the transmissions engineering department, IHC's Motor Truck Division.

What the rubber industry would *like* to make is a series of standardized air springs that could be "shelf items" like tires, said Goodyear's A. B. Hirtreiter in April at **SOUTHERN CALIFORNIA SECTION.**

Left to right: J. C. Buckwalter, Section chairman; Speaker Hirtreiter; and R. A. Garrison, Section vice-chairman, Truck and Bus activity.

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University of Washington's College of Engineering conducted its Seventh Annual Motor Vehicle Maintenance Conference March 24–25 . . . with the **NORTHWEST SECTION** one of six co-sponsors.

Section vice-chairman and chairman of the Conference Trustees, L. M. Landwehr (left), opened the meeting and introduces "Kick-off" Speaker Lee Ketchum. Ketchum was responsible for originally getting the conference underway seven years ago, served as the first chairman, and as chairman for several years following.

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SAE President W. K. Creson was on hand April 14 to present awards at the **PITTSBURGH SECTION** annual student award competition . . . first place winner was Louis J. Polaski of Carnegie Institute of Technology, second place winner was David Gestler of University of Pittsburgh. L. to r.: W. M. Rohrer Jr., faculty advisor, University of Pittsburgh; Winner Polaski, who spoke on "Power Losses;" W. K. Creson; Section Chairman R. P. Gilmartin; D. W. Ver Planck, head, Department of Mechanical Engineering, Carnegie Institute of Technology; Winner Gestler who spoke on "Torsion Bar vs Air Spring Suspension."

DETROIT'S JUNIORS . . .
mark 10th anniversary

V. Ayres
1947-48

R. K. Hirchert
1948-49

P. M. Rothwell
1949-50

J. T. Bowling
1950-51

R. H. Smith
1951-52

W. E. Oliver
1957-58

ON their 10th anniversary, the **DETROIT SECTION JUNIOR ACTIVITY** is celebrating a decade of expansion and development — led by the junior Executive Committee chairmen pictured right and left of this article.

In December of 1947 a survey indicated that 500 Detroit Section Junior Members **might** be interested in a Junior group distinct from the regular Section . . . in December of 1958, 1100 Junior members were not only interested, but active. Unique in SAE, the Detroit Junior Activity is the first and only organization of its kind throughout SAE Sections.

The plight of the Juniors was first heard in 1947 when a representative group of Junior members met with Detroit Section Chairman Robert Insley. The Juniors pointed out that a separate Junior Activity, organized along the same lines as the regular Section, would allow the younger members to participate more actively. When one out of three Juniors responded enthusiastically to the prospect of a Junior Activity, the group was formally organized with Vincent Ayres chairman and Harry E. Chesebrough Senior member Counselor.

C. F. Kettering launched the first meeting (April 1948) speaking, appropriately enough, on "Opportunities for the Future." The second meeting was an all-Junior program "three-ring circus" — which has become the popular trademark — three Junior members present papers on the same subject, three Senior members are available for questioning, and a Junior acts as moderator.

Field trips, panel discussions, dinner meetings . . . plus the planning and coordination necessary for each meeting have provided a well-rounded program for the Junior's Section year.

Committees on Membership, Meetings Publicity, Meetings Attendance, Meetings Operation, Reception, Preprint, and Student Activity, give any of the 1100 Junior members an opportunity to participate.

Leaders of the Activity include a Vice-Chairman, Junior Activity, on the Detroit Section Governing Board, and a Junior Activity Executive Committee. Section Vice-Chairmen since 1947 have been: Harry E. Chesebrough, 1947–49; Philip J. Kent, 1949–50; Carl T. Doman, 1950–51; Vincent Ayres, 1951–52; John P. Butterfield, 1952–53; John R. Splitstone, 1953–54; Charles T. Langley, 1954–55; Milton J. Kittler, 1955–56; Charles W. Ohly, 1956–57; Harold C. MacDonald, 1957–58.

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N. J. Van Halteren
1952-53

J. A. Miller
1953-54

W. S. Coleman
1954-55

J. A. Crabtree
1955-56

M. G. Gabriel
1956-57

Participants in the January 27 "three-ring-circus" meeting, left to right: Senior consultants — J. E. Charipar, chief styling engineer, Chrysler Export Division; H. Drew, chief engineer, GMC Overseas Operation; and S. Daniloff, Foreign Car Associates. Speakers — A. P. Anderson, Ford Product Engineering; R. F. Jenson, American Motors Automotive Research; and D. L. Cohoe, Chrysler Engineering. Subject of the session was "Probing the Puddlejumpers."

Parks Air College captured the Student Award Banner in **ST. LOUIS SECTION'S** annual paper competition. For the past three years, Section members have staged and judged papers presented by students from Missouri School of Mines and Parks Air College. Individual winners receive cash prizes, while the winning Student Branch gains custody of the banner.

Section Chairman W. E. Williamson (right) presents cash awards to student winners, left to right, Jerry Whitehouse of Missouri School of Mines; and N. Stack and G. Wood from Parks Air College.

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The importance of automotive ground support vehicles in missile launching was described by George D. Evans of Sperry Utah Engineering Laboratory at **SALT LAKE GROUP** in March.

Pictured at the meeting, left to right: O. W. Harrah, Section vice-chairman; Speaker Evans; J. P. Bywater, Section chairman; and J. C. Bates, Section secretary.

SAE NATIONAL MEETINGS

- **June 8-13, 1958, Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.**
- **August 11-14, 1958, West Coast Meeting, The Ambassador, Los Angeles, Calif.**
- **September 8-11, 1958, Farm, Construction and Industrial Machinery, Production Forum, and Engineering Display, Milwaukee Auditorium, Milwaukee, Wis.**
- **September 29-October 4, 1958, Aeronautic Meeting, Aircraft Manufacturing Forum, and Engineering Display, The Ambassador, Los Angeles, Calif.**
- **October 20-23, 1958, Transportation Meeting, Lord Baltimore Hotel, Baltimore, Md.**
- **October 21-24, 1958, Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.**
- **November 5-6, 1958, Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.**
- **January 12-16, 1959, Annual Meeting, and Engineering Display, Sheraton-Cadillac and Statler Hotels, Detroit, Mich.**

the SAE story for May

SAE Handbook Priced Toward Breakeven Point

PRICE TO MEMBERS of one copy of the SAE HANDBOOK has been raised from $1 to $3.50, effective with the next Handbook, scheduled for publication by January 1, 1959.

SAE Council made the increase at its April 11 meeting, upon recommendation of the SAE Finance Committee.

Pointing up need for the advance, the Finance Committee stressed its established philosophy that the cost of special services should be charged to the members desiring them.

A $5 price — which would put SAE Handbook on a self-supporting basis — would be more logical than the $3.50 price recommended, the Finance Committee said. "However," it added, "in the light of current economic conditions, it would seem propitious at this time not to make too big a jump in price; to consider a second increase at a later date when conditions are more favorable."

"Continued expansion of Society services into new technical areas, combined with increased requirements in traditionally-served areas, requires the production of additional revenues," the Finance Committee adds.

At the same time it recommended increase in SAE Handbook prices, the Finance Committee told Council of a long-range financing study which it had recently started. The aim is to equip the Society with long-range policies to which projected expansion of services may be progressively keyed.

Non-member Prices

Non-member price for the SAE Handbook remains at $20 per copy, but a new scale of quantity prices and discounts have been set up to encourage buying by companies having SAE members in their employ.

1959 SAE Handbooks will be available to companies in which SAE members are employed at a single-copy price of $12, and:

- At a 10% discount, if the order reaches SAE headquarters **before** September 1, 1958;
- At quantity prices running as low as $8 per copy for more than 15 copies.

Pope, Jr., . . .

. . . to deliver 1957 Horning Memorial Lecture and receive Award.

ARTHUR Wilson Pope, Jr. has been selected by the Horning Memorial Board of Award to deliver the 1957 Horning Memorial Lecture. Cited for "his more than 30 years of distinguished active service in the field of mutual adaptation of fuels and engines," Pope will receive the Horning Memorial Award following his lecture presentation.

Pope's paper, entitled "Single-Cylinder Engine-Fuel Research," will be given on June 11, during SAE Summer Meeting in Atlantic City, at the Horning Award Luncheon.

A. W. Pope, Jr.

Since 1924 Pope has been with Waukesha Motor Co., and now serves as chief research engineer. He is a graduate of MIT and has been a member of SAE since 1925. His SAE offices have included chairman of the Milwaukee Section (1936–37), vice-president representing Diesel Engine Activity (1937), and SAE Councilor (1956–58).

The Horning Memorial Award, established in 1938 in memory of the late Henry L. Horning, will be presented by Lloyd Withrow, chairman of the Horning Memorial Board of Award.

Maybe you heard it . . .

. . . over a recent NBC nation-wide radio program honoring SAE engineers.

"TOMORROW'S MEN OF TODAY," these SAE engineers, paving the way for

". . . Man, who must reach ever farther out and move ever faster."

PROPELLING POWER is the story . . . AND it's the story of SAE (which came into being when foresighted engineers envisioned the practical production of the "horseless carriage" way back when!)

There is something of SAE in every passenger car, truck, bus— "in every military and civilian aircraft produced in our nation today."

Missiles-rockets-satellites — tomorrow's problems being wrestled with NOW . . . and by SAE engineers.

"So," as NBC's Alex Dreier said, "Godspeed to the automotive engineers . . . tomorrow's men of today!"

136 ENGINEERS . . .

. . . comprise first SAE Consultants booklet

136 SAE CONSULTANTS, from the Belgian Congo to California, compose the first annual SAE Consultants listing, recently released through SAE Placement Service. The 38-page booklet contains SAE members available for on-call, part, or full-time consulting work, and has been sent to the more than 1000 prospective employers now using SAE Placement Service. Their reaction has been very favorable. Some of the larger companies have requested additional copies for distribution.

Geographic availability, speciality, and background are submitted by each consultant, and indexed according to locational preference. 36 experienced engineers will go "anywhere", specific areas include EASTERN U.S.—42; WESTERN U.S.—21; SOUTHERN U.S.—6; CENTRAL & MID-WEST—34; and CANADA—3. Two consultants, living in England and Monaco, prefer European work, while two in Hungary and West Africa state no preference.

A wide variety of engineering areas are offered, with general to specialized experience available. Specializations such as tape-recording smokemeters, hard facing by applying Stellite, tropical conditions in automotive fields, and design of pre-fabricated stairways, are indicated by the engineers. Experience in cost reduction, sales, and factory organization, are noted as well as design, construction, and development in many engineering fields. In addition, members offer services in estate planning for engineers, interpretation of principles of engineering for law firms, photography, and editorial writing.

All consultants listed will be checked annually for up-to-date data, and additional consultants will be added. Requests for copies of SAE CONSULTANTS should be sent to the SAE Placement Service; SAE consultants may be contacted directly.

You'll . . .

be interested to know

JEROME LEDERER, Flight Safety Foundation, has been appointed one of SAE's three representatives on the Daniel Guggenheim Medal Board of Award. He will serve three years, succeeding M. G. Beard whose term expires September 30.

Other SAE members currently serving three years on the Board are D. R. Shoults, General Electric Co., and J. B. Wassall, Lockheed Aircraft Co.

The Medal is awarded annually "honoring persons who make notable achievements in the advancement of aeronautics."

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R. E. CROSS, Cross Co., is now SAE's Special Advisor to the President on Electronic Computers.

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AIR TRANSPORT, AIRCRAFT, BODY, AND DIESEL ACTIVITY COMMITTEES have two new members each. C. W. Maynard, Union Carbide Corp., and L. G. Romberg, Scandinavian Airlines System, have been appointed to Air Transport; Harold Hertenstein, McDonnell Aircraft Corp., and B. R. Teree, Greer Hydraulics, to Aircraft; R. E. Halatek, Plymouth Division, Chrysler Corp., and R. E. McMillen, Budd Co., to Body; A. H. Fox, Standard Oil (Indiana), and R. E. Taylor, Murphy Diesel Engine Co., to Diesel Engine.

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J. H. FAMME, Convair Division, General Dynamics Corp., is Planning for Progress Committee's newest member.

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THE NEED FOR BASIC TABLES OF SCIENTIFIC DATA relating to physical constants and properties of materials is now under survey by the newly established Office of Critical Tables.

Sponsored jointly by National Research Council and National Academy of Sciences, the Office of Critical Tables will:

- **Coordinate compilation of critical tables on a continuing basis;**
- **Develop uniform editorial standards for their presentation;**
- **Provide a central indexing and directory service for all tables projects in progress.**

JOHN M. CAMPBELL, General Motors Research Staff, who attended the organization meeting on February 3, has been appointed SAE's representative on the Advisory Board, Office of Critical Tables.

What Tomorrow's Diesel Fuel Will Need

Based on paper by

GROVER C. WILSON

Ethyl Corp.

(Presented at SAE Metropolitan Section)

THREE improvements needed for diesel fuels, if they are to keep pace with developments in high-speed diesel engines, are:

- Reduced sulfur content where it is running well above the average.
- Better stabilizers.
- Combustion improvers.

For two reasons future diesel fuel should show a reduction in sulfur content for fuels that are now approaching the high limits:

1. Engine tests have now proved conclusively that the use of high-sulfur fuel causes an increase in engine deposits and wear.
2. With certain refinery equipment combinations, an economic way for reducing the sulfur content of diesel fuels is now available.

Hydrogenation has long been known to reduce the sulfur content as well as to increase the cetane number of diesel fuels. Its use for these purposes, however, had to await an economic supply of hydrogen. Hydrogen is now available in most refineries as a by-product of equipment installed for reforming low-octane naphtha to high-octane gasoline stocks. In several refineries, some of this hydrogen is being used to up-grade distillate fuels.

The use of stabilizers and combustion improvers will be particularly needed with the catalytically cracked distillates that will probably be used increasingly to meet the rising demands for diesel fuels.

Stabilizers are needed to minimize the formation of both insoluble residues and soluble gummy material. No single stabilizer as yet solves the problem for all fuels. Thus, today, stabilizer selection is largely a tailoring proposition. Extensive development programs are under way. Also, at the present time there is great need for procedures that will identify unstable fuels and those that become unstable upon blending or during storage.

There is a great need for combustion improvers, which will make diesel fuels burn more completely in engines. Such additives would increase engine output, reduce combustion deposits, and improve exhaust conditions. Research on this type of additive has offered promise, but no practical solution for distillate fuels has yet been reported.

An ignition-improving compound — amyl nitrate — is already available. It increases the cetane number and shortens the period of delay between fuel injection and its rapid burning in the engine. Under certain operating conditions ignition quality becomes important. The effect of low temperature of the compressed air at the time of fuel injection can be overcome by improved fuel ignition quality. Also, proper timing can be obtained for the beginning of fast combustion, which improves engine efficiency.

To Order Paper No. S64 . . .
on which this article is based, see p. 5.

3 Adhesive Types Meet Auto Requirements

Based on paper by

C. J. RAWSON

Chrysler Corp.

THREE major types of adhesives are being used in the automotive industry. These are:

1. **Thermosetting or vulcanizing adhesives** which are used primarily for brake shoes and transmission bands.
2. **Air drying or solvent evaporation adhesives** which are used for door weatherstrips, decklid weatherstrips, and as trim adhesives.
3. **Water dispersed adhesives** both of the milk latex variety, used for carpet and trim applications, and the reclaimed rubber and asphalt dispersed type, used for roof and paper felt silencer pads.

Thermosetting or vulcanizing adhesives go through a chemical change during the process of curing. The chemical change, which is basically a polymerization process, forms a new composition which adheres tightly to the materials being bonded. This adhesive is strong and tough enough to withstand the severe abuse endured by the bond between the brake lining and the shoe and is used primarily for this application and for transmission band bonding.

Solvent evaporation or air drying adhesives are usually made from elastomeric polymers and resins which may be modified by the addition of tackifiers or plasticizers and are put into solution with a solvent. The solvent also acts as a viscosity controlling agent making the adhesive easy to apply. It then evaporates, leaving the tacky compound for adhesion to the materials being cemented.

To obtain a good bond with this type of adhesive, it is important to effect as complete a removal of solvent from the cement as possible. If any traces of this solvent are locked into the cement film, bubbling, porosity, or softness will result. Solvent evaporation is not a problem when cementing fabrics or porous materials. When adhering rubber, vinyl film, or other dense materials, a flash-off time to allow the solvent to escape is essential in obtaining the optimum bond strength.

With this type of adhesive, care should be taken to avoid the bonding of materials which will either attract the plasticizers out of the cement or allow the cement to attract the plasticizers away from the material. If the cement loses its plasticizers, it becomes brittle, and if it gains them from the adjoining materials, it becomes soft. This type of adhesive is used for bonding door and decklid weatherstrips and as a trim adhesive.

The third major type of cement is the water dispersion or latex type. The two big advantages of this type of cement are the elimination of fire hazards, and high heat resistance. Such features make possible their use on the body-in-white, since they are not adversely affected when passed through the priming and painting ovens. These cements are generally of two classifications, either reclaimed rubber-and-asphalt water dispersions or milk-latex cements. They may be applied by either spray or roller coat methods. The body and consistency may be varied to accommodate the type of application. The largest single use of these cements is the attaching of sound deadener pads (paper felt, fiberglas, and such) to the automobile body.

To Order Paper No. 34C . . .
on which this article is based, see p. 5.

Station Wagon Grows in Popularity

Based on paper by

G. H. BROWN

Ford Motor Co.

STATION wagons are gaining in sales percentagewise, but the absolute rate of growth has decreased in the past few years. Data show the growth to be mainly at the expense of 2- and 4-door sedans.

New station wagons are bought by people of higher than average income and ownership is heavier among young families (under 45 years) than older ones.

Contrary to current belief, the owners of station wagons are not exclusively the suburban dwellers. They own about one-sixth of them, distribution being widely diffused in city as well as country.

Station wagons are used to a surprising degree for business purposes, that is, for combined business and personal use. And except for hauling children around, they are used to transport objects rather than people. Also, they

are used for long and short trips, neither predominating.

About 35% of station wagons are sold to persons who trade in another wagon, whereas 55% are sold to persons who trade a sedan. All studies show intended purchase still exceeds current ownership.

To Order Paper No. 27B . . .
on which this article is based, see p. 5.

Airlines Can Use Computer Techniques

Based on paper by

LAWRENCE ROSENFELD

Rusan Corp.

THERE are many opportunities for applying the techniques of operations research and for taking full advantage of the speed, flexibility, and capacity of an electronic computer in the airline business.

A few of the more important areas are:

1. Market research (sales and traffic forecasting).
2. Determining flight schedules.
3. Assigning flight crews.
4. Maintenance scheduling.
5. Long-range planning.

These major areas do not present distinct, unrelated problems, for the answer to one problem will affect and influence the answers to others. This dependence and interlocking relationship does raise the possibility and feasibility of eventually encompassing the major company functions within an integrated system.

Consider the traffic forecasting problem typified by a passenger originating in Boston and terminating in Minneapolis. There are three alternate routes possible. (Flying a different airline between the same two cities is not classified as an alternate route.) The passenger might fly Boston-Chicago-Minneapolis, Boston-Detroit-Minneapolis, or Boston-New York-Minneapolis. Consider, for example, Northwest Airlines, which is the sole nonstop Chicago-Minneapolis carrier. It competes with Capital on both the New York-Minneapolis and Detroit-Minneapolis portions of the remaining two alternative routes. What optimum strategy should Northwest's marketing people then employ to obtain morning traffic originating in Boston and terminating in Minneapolis?

Computer Gives Answers

Present marketing procedures by and large could not adequately answer this problem. The successful decisions are left to chance since the evaluation did not include flow external to the system, and therefore would not reveal whether a Boston passenger is more apt to fly Boston-Chicago-Minneapolis than Boston-New York-Minneapolis. If the later alternative is more apt to be chosen, then Northwest is a decisive loser to Capital. It is impossible for Northwest to obtain any Boston morning traffic since its morning flight to Minneapolis leaves prior to any Idlewild landing from Boston.

A medium- or large-scale computer system could easily cope with the problem. It would be possible to store in the memory of the computer all of the schedules of all airlines having common points with Northwest's routes. By statistical methods, assuming data can be obtained, an analysis could be made of the numerous possible flows affecting Northwest. Then by resorting to a theory of games procedure, it would be possible for the computer to evaluate the effects of various possible strategies of scheduling to obtain a maximum payoff. Applying the theory of games would be operations research's contribution, while the computer would make it possible to carry out the numerous and lengthy calculations.

To Order Paper No. 50A . . .
on which this article is based, see p. 5.

Phosphorus 32 Aids E-P Lubricant Study

Based on paper by

E. H. LOESER, R. C. WIQUIST, and S. B. TWISS

Chrysler Corp.

RADIOACTIVE phosphorus 32 is being used as a tracer in the study of the film-forming mechanism of the extreme-pressure additive — zinc dialkyl dithiophosphate. This investigation has demonstrated that:

- A chemical film is formed on the surface.
- The amount of bound phosphorus is dependent on the surface treatment, and increases with time and temperature until equilibrium conditions are reached.
- The dynamic test conditions greatly increase the amount of bound phosphorus in the film, indicating that surface temperature, pressure, or wear has a marked effect on film formation.
- The quantity of bound phosphorus in dynamic tests increases with load and speed.
- The amount of bound zinc (X-ray spectrometer determination) in the static tests increases as a function of temperature, but not as rapidly as bound phosphorus.

Zinc dialkyl dithiophosphate is widely used in engine oils to reduce wear and prevent scuffing in valve trains.

(This paper was sponsored by the SAE for presentation at the recent Nuclear Engineering & Science Conference. Copies are available from the American Institute of Chemical Engineers, 25 West 45th St., New York 36, N.Y., for 50¢ each.)

Four Extrusion Methods Produce Parts

Based on paper by

D. J. DAVIS

Ford Motor Co.

(Presented at SAE Detroit Section meeting)

IN RECENT years, extensive development work in this country has improved upon and added to early extrusion techniques. Today, four basic cold forming methods are utilized in production processes (Fig. 1).

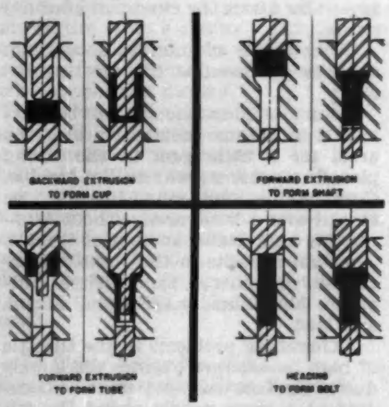

Fig. 1 — Four commonly used cold-extrusion methods.

The first method, backward extrusion, is used to form cup-like objects from a solid cylindrical slug. The slug is enclosed in a die, and the moving punch causes the slug to extrude back along the punch.

The second method is forward extrusion. Here a cylindrical slug is forced through a throated die of suitable cross section to form a stepped shaft.

The third method is a modification of the forward extrusion method to form a tube. In this case, the punch is shaped to maintain an internal cavity. As illustrated, stepped tubular

parts can be formed by this method.

The fourth method is an expansion of the well-known cold heading technique, where a rod or wire is upset in a closed die to form a flange or head at one end.

By a combination of these methods, it is possible to build up a process sequence to accurately form many parts.

Advantages of cold extrusion over other processes include material savings, reduced machining requirements, and improved physical properties of the parts thus formed.

To Order Paper No. S65 . . . on which this article is based, see p. 5.

Fuel Additives Reduce Gum Deposits

Based on report by

JOHN F. BEACH

Shops & Garages, County of Los Angeles

(Of SAE Southern California Section Meeting)

FUEL additives are the best method devised so far for preventing gum deposits. Air-fuel ratio, engine design — and even the amount of smog in the air — also affect the extent of gum deposits.

Other points of interest about gum deposits discussed at the meeting include:

- Gum buildup should not be permitted to become isolated in any one area, for a little gum in the wrong place can cause a great deal of trouble. Considerable gum may, however, be spread over a large area without causing any appreciable amount of trouble.
- Gum deposits in the throttle body contain phosphorus, zinc, barium, cadmium, aluminum, magnesium, silicon, and lead.
- Gumming problems in the throttle of high horsepower engines are largely due to the fact that they must be operated at a more nearly closed throttle position. This builds up throttle deposits in the carburetor.

New Roads Herald Heavier Truck Loads

Based on talk by

CHARLES B. RAWSON

Commercial Car Journal

(Presented at SAE Virginia Section)

ALL guesses and prognostications indicate a 60-ft overall length for the truck-trailer combination of the not-too-distant future. Such a combination would have a 102-in. overall width. With a single trailer, perhaps 40 or even 45 ft long, carrying capacity would be in the vicinity of 125,000 lb gcw, whereas with a "double bottom" and short tractor, the load could reach 150,000 lb gcw.

Power for this mammoth will be at least 500 hp. The power source can be a diesel or turbine, and in some areas an LP gas unit.

Tire Engineers Seek Better Materials

Based on paper by

R. H. SPELMAN

General Tire & Rubber Co.

THE incompatible demands for higher speeds and more road cushioning pose a continuing problem for tire engineers. Increases in flexing frequencies and amplitudes call for critical analysis of the weak points in the whole tire structure involving cord, cord-rubber bond, and the rubber envelope.

There is need to focus attention on the immediate loss of rubber properties due to high temperature, and to the maintenance of these properties under prolonged exposure to these elevated temperatures. Past experience shows the weakness most likely to show up at the rubber to adhesive interface rather than at the cord-adhesive interface, due presumably to the combination of high stress concentration and the lowest tensile strength. There is some evidence of a necessity to change from conventional elastomers and curing systems to achieve the necessary high-temperature bonding strength between the rubber and the adhesive system. Recent success in the development of a high-temperature-resistant airplane tire using butyl rubber shows what can be done by special compounding.

Since maintenance of good high-temperature properties after prolonged exposure is mainly an oxidative problem, it should be possible to improve tire performance by using inert nitrogen in place of air for inflation where sustained high-speed driving is expected. More distantly, performance could be improved through the use of new elastomers less susceptible to oxidative degradation than conventional rubbers such as natural rubber and SBR. New saturated rubbers could extend tire life, and with the Air Force emphasis on high-temperature performance, there is hope for the development of more stable rubbers. Any major change in type of rubber or cord will involve the development of new, compatible adhesive systems capable of equally advanced performance.

The fatigue resistance of cord needs improvement. Rayon cord fatigue life can be affected by the adhesive system, but thus far changes in the adhesive have usually led to loss of adhesion. A change in both cord and adhesive system seems needed to gain fatigue life without loss of adhesive strength.

Higher-strength tire fabrics will be needed in the future. The use of wire points to this, and other synthetic fibers are certain to be examined. But new and stronger cords will be useless unless adequate adhesive systems can be developed.

Fibers currently being considered for cord material are:

- Nylon 6, based on the chemical intermediate caprolactam. Adhesive system for Nylon 66 will serve for Nylon 6.
- Fortisan 36, a regenerated cellulose, compatible with adhesives used for rayon.
- Dacron. Dimensional stability is good, but adhesives are a real problem.
- Glass fibers, which are inherently brittle, but a combination lubricant and adhesive system might be developed which would reduce interfiber abrasion and provide adequate adhesion.
- High carbon steel wire, which presents a new field of adhesive requirements as they pertain to rubber-metal bonding.

To Order Paper No. 28D . . . on which this article is based, see p. 5.

Road Testing Best on 5 Counts

Excerpt from paper by

EDWARD GRAY

Chevrolet Motor Division, GMC

MUCH valuable information is obtained by engineers on a road test, because it has the following advantages over routine testing:

1. The participating engineers experience a freedom of operation that is conducive to effective vehicle evaluation.

2. Dressed in casual clothes and exposed to new and constant changing surroundings, the engineers' interest in this entirely different frame of reference tends to sharpen their perceptiveness.

3. The engineers are subjected to the rigors of road conditions and fatigue factors that are difficult to produce on the proving ground.

4. The mealtime discussions and informal evening critiques on daily experiences can be very productive.

5. Finally, for security reasons the engineers often do the necessary mechanical work or exchange test units in their cars during stops. This intimacy with the problem is highly beneficial.

To Order Paper No. S52 . . . on which this article is based, see p. 5.

Instrument Pictures Flight for Jet Pilot

Based on paper by

MICHAEL V. FIORE

Northrop Aircraft, Inc.

Fig. 1 — In this integrated navigational display instrument developed by Northrop, the pilot sees his own aircraft as a symbol moving over the terrain. The "shrinking circle" tells the pilot if he can or cannot return to his point of departure. Here the circle tells him he cannot reach his destination.

IN THE integrated display of navigational flight information developed by Northrop for jet interceptors, all information is centered horizontally before the pilot. It appears to him as though he were looking downward at the terrain through an aperture in a table top, viewing his own airplane from above.

By means of this simple instrument the pilot obtains direct, usable information concerning his present location, bearing to target, point of return information, and possible alternate destination, the last two based on fuel consumption data.

As shown in Fig. 1, the aircraft symbol on display represents the aircraft being flown and moves over a terrain map "below" it in direct relation to actual movement of the aircraft. This symbol changes direction with the aircraft. The terrain map may be projected on the display face or presented on a cathode ray tube with the aircraft and airborne target symbols superimposed thereon.

The terrain must, of course, be anticipated when establishing the flight plan prior to take-off. There is no space problem if microfilm maps are used. Terrain features may be identified easily on such maps by lettering or color code. Known defense concentrations and weather conditions could also be marked for avoidance.

The pilot is informed continuously of his precise geographical location without reference to visual contact fixes or dead reckoning computation. Bearing to target or destination could be supplied by means of a great circle route superimposed on the map, extending from present location to destination. Alternate routes can be made available to the pilot by means of a selector which would instantly substitute route lines. If desired, selected course ADF bearing, and command heading could be indicated by means of a cursor moving about the periphery of the map display. In this manner the pilot receives a spatial representation of his position with relation to his desired course, terrain, and bearing. Bearing to target and/or destination information is thus supplied directly.

Point of return, or point of no return, based on fuel supplies, is supplied to the pilot on the integrated display by means of "shrinking circle" indication superimposed on the display with the aircraft symbol centered in it. The circle shrinks as the aircraft's radius of operation diminishes. Input data to such an indication will include throttle setting, pressure altitude, gross weight, angle of attack, engine efficiency, and fuel quantity. The pilot can select his power setting, best altitude, and best angle of attack on the basis of the circle's radius. Alternate destinations within the operational radius of the aircraft are identified easily on the map display.

The pilot can change the map's scale at will. When the symbol reaches the perimeter of the display it can be recentered. When turns of more than 90 deg are made to maintain proper orientation, the map-symbol relationship should be maintained in a forward moving direction upon completion of the turn. This avoids possible problems of control and direction reversal.

To Order Paper No. 40B . . . on which this article is based, see p. 5.

Nodular Iron Solves Diesel Sleeve Problem

Based on talk by

H. F. PRASSE

Hydraulics Products Division, Thompson Products, Inc.

(Presented before SAE Cleveland Section)

USE of nodular iron for the cylinder sleeves of a heavy diesel engine has resulted in diminished bore wear and reduction in blowby as well as piston ring radial wear.

Experiments in the use of nodular iron were prompted by a customer's complaint of sleeves actually bursting. Examination showed the trouble to be due to an incapacity of the existing material to withstand the stresses imposed by the combustion pressures.

To determine the wear properties of nodular iron sleeves, a 200-hr full-load dynamometer endurance test was run with an engine whose wear characteristics were known and on which data oil consumption and blowby rate were available.

The bore wear averaged less than 0.0008 in., comparing favorably with the wear of standard sleeves. Oil consumption was less, being 500 mpq average in the standard engine and 873 mpq in the same engine equipped with the nodular iron sleeves. Blowby rate was reduced 25% and piston-ring radial wear was substantially reduced. Examination of the sleeves after test revealed numerous microscopic pits on the sleeve surface.

An Unexpected Blessing

The distribution of nodular graphite affords a theoretically ideal wearing surface. Being softer than the basic iron structure, the graphite nodules wear away or pull out to form microscopic voids in which the engine lubricant is retained. This tends to provide relatively uniform lubrication to the

piston rings and results in minimum wear.

Our experience seemed to indicate that an interrupted surface in the bore of the cylinder sleeve was highly beneficial as far as antiscuffing and long life were concerned. But when we tried to develop such a sleeve we found the interrupted surface must be microscopic and noncontinuous, or excessive oil consumption will be the outcome.

Tire Thump Can Be Controlled

Based on paper by

GUY J. SANDERS

Armour Research Foundation
Illinois Institute of Technology

A TIRE'S susceptibility to thump can be predicted from the difference frequency between diametrical and circular modes of vibration, as follows:

1. Less than 4 cps difference frequency will cause thumping only below 23 mph.
2. Between 4 and 7–8 cps can produce plainly audible thump between 20 and 35 mph.
3. From 8 to 10 cps will produce thump below 23 and a little above 35 mph, but somewhat less between 23 and 35 mph. Below 20 mph the exciting force is reasonably small and above 35 mph the masking noise is large enough to reduce the effect of the thump noise.
4. Above 10 cps the frequency separation is large enough to make the sound or vibration waves add in a relatively disorganized manner which will sound more like roughness than thump.

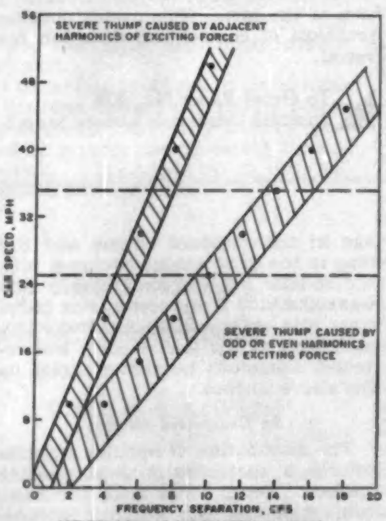

Fig. 1—Predominant thump speed variation for various tire resonant frequency separations.

Most of these factors are plotted in Fig. 1, which shows what the acceptable tire natural frequency ranges are from a thump standpoint. If the difference between natural frequencies of the circular and diametrical modes is plotted on this curve, the primary thump speeds will be those for which the two natural frequencies are in the upper shaded region, with a little less thump when they are in the lower shaded region. At speeds where the natural frequencies are in the clear region between the two shaded areas, thump produced by the tire will be reduced.

Using this technique, the natural frequencies and Q's of 6.70, 7.10, 7.60, 8.00 and 8.20 tires were measured on $4\frac{1}{2} \times 15$, 5×15, $5\frac{1}{2} \times 15$, and 6×15-in. rims. Curves prepared from these data showed that for a given size tire the frequencies of both modes of vibration increase as rim width is increased, and that the difference between the two frequencies changes very little. It was also found that for a given rim width the frequency of the two modes decreased as tire size increased, and again, the difference between the two frequencies changes very little.

How to Reduce Thump

The criteria for minimum thump is to have a shape and construction which does not permit the coincidence of the two natural frequencies with two revolution rate harmonics in the 20–35-mph speed range. This was substantially accomplished in 6.00-16 tires and partially gained in most new 14-in. tires. These considerations of critical thump speeds hold in general for all cars.

If there are body panels with sharply tuned resonance very close to these frequencies, thump level will be amplified, which explains the difference between models. A slight lack of trueness in body or frame can upset a designed mount attenuation. Overtightening the mounts may reduce or increase the level, depending on what the mount resonant frequency is compared with the tire natural frequencies.

To Order Paper No. 25A . . . on which this article is based, see p. 5.

2-Engine Powerplant Lacks Flexibility & Economy

Based on paper by

K. M. LEECH

Cummins Engine Co.

(Presented at SAE Central Illinois Section)

THE 2-engine powerplant used with off highway equipment is at present restricted to: a 2-axle drive, and a torque converter transmission. This lack of flexibility plus the higher initial cost of two transmissions puts the 2-engine arrangement at a definite disadvantage, compared to a single-engine system.

Lack of a compounding gear capable of connecting with a single axle makes the 2-axle drive a must. No presently available transmission is capable of providing the required gear splits and transmitting the torque.

The torque converter transmission is required because the two engines are finally compounded at the wheel-to-ground contact. The converter characteristics are such that differences between engines, whether caused by engine condition or throttle position, can be absorbed. Thus, the converter transmission permits each engine to perform to the best of its ability.

Initial cost of two complete converter transmissions runs quite a bit higher than a comparable transmission for a single engine of the same rated horsepower. For example, the total transmission cost for a 2-engine unit in the 400-hp size is 60% greater than the comparable transmission for a single 400-hp engine. When talking about transmissions in the \$4000–\$5000 range, this is a considerable extra expense.

To Order Paper No. S70 . . . on which this article is based, see p. 5.

Gasoline Engine Faces Three Problems

Based on talk by

JOHN S. WINTRINGHAM

Ethyl Corp.

(Presented before the SAE Baltimore Section)

THERE are three problems ahead for the gasoline engine:

- Surface ignition, including rumble.
- Friction.
- Cost of octane improvement.

Surface-ignition tendencies will be increased by further increases in compression ratio, which will also bring problems of higher friction because of higher pressures in the cylinders. The surface-ignition tendencies can be alleviated by fuel additives. The friction may be reduced by research in engine design.

Costs of raising octane numbers above present levels increase rapidly for successive unit increases, using known refinery processes. New technology may reduce these costs.

Further increases in compression ratio produce smaller and smaller returns in power and economy. Thus, there is now visible a ceiling, well above present

superpremium octane levels, above which octane improvement costs offset gains in fuel economy. This ceiling can be raised when new refinery technology lowers octane improvement costs.

Air Springs Come In Three Basic Types

Based on paper by

A. B. HIRTREITER
Goodyear Tire & Rubber Co.

(As reported by William E. Achor, SAE Southern California Section Field Editor)

WHILE there are many sizes and shapes of air springs, there are only three basic types:

1. Bellows.
2. Rolling seal and piston.
3. Friction seal and piston.

The circular bellows has a history of excellent service life in commercial vehicles, particularly where space permits a large expansion chamber.

The elongated bellows has a very high load-carrying capacity and adapts itself into most commercial chassis, using very little lateral space. This style is difficult to manufacture, consequently the cost is relatively high.

The rolling seal and piston is probably the oldest form of air spring; its patent history dates back to 1847. The many variations of this type include the rolling lobes, the restrained rolling lobes, the single convolution diaphrams and the supported sleeve. Good fatigue life and reliability can be gained when good design practices and careful workmanship are used.

A controlled load-deflection or rate curve, can be obtained by changing piston contour, adding a skirt, or changing the cord angle in the construction of the air spring. Selection of proper cord angle when designing and building an air spring is very important. Many characteristics depend upon the accurate placement of the cords.

Each suspension system takes advantage, to some degree, of two inherent properties:

1. Approach to the ideal S-shaped load-deflection curve.
2. Automatic height control.

An increase in load-deflection curve with additional load is the reason air-suspended vehicles have almost constant riding qualities regardless of load.

To Order Paper No. S79 . . .
on which this article is based, see p. 5.

Flying Platform Shows Steady Advance

Based on talk by

J. B. NICHOLS
Hiller Helicopters

(Presented at SAE Detroit Section)

WHILE the Flying Platform is basically a low-speed machine, even slower than other helicopters, it will develop very high speed if it can be tilted over far enough to become a ring-wing type of aircraft.

Early flights of the platform proved it to be easier to control than helicopters employing overhead rotors, but for this a price is paid. The ducted propeller made possible a very small diameter machine, but at the same time reduced inertia and damping, making the machine as sensitive to gusts and other disturbances as it was to the pilot's control.

Ducting the propeller also increased the pitchup characteristics of the rotor sliding through the air. This is known as speed stability and was so great as to make difficult maintaining the platform in forward flight at any but the most modest speeds. To raise speed to a reasonable rate, the pilot had to lean forward at an extremely high angle.

Raising the pilot increased both stability and control of the machine markedly. This moved the c.g. closer to the center of drag of the machine to make it less sensitive to gusts and also provided the pilot with a greater moment arm, allowing him to exert greater tilting moments and so to attain higher forward flight speed. Then, to make platform flight as simple as originally hoped, damping vanes were added. These are controlled automatically by gyroscopic means (Fig. 1).

In order to obtain competitive speeds it may be necessary to evolve the machine toward the coleopter, or ring-wing type of aircraft. In many respects, then, the ducted fan principle may take precedence over the principle of kinesthetic control. This might be a very favorable trade since the same power-lifting system which provides low performance in a platform type of aircraft is capable of providing speeds of over 400 mph if it can tilt over all the way.

The kinesthetic control system is hardly applicable in this mode of high-speed flight, nor probably for any but one-man platform flight, since it is difficult to imagine successful flight by this method with two or more people, each with a somewhat different sense of balance on the same machine.

The U.S. Army has another application of the ducted fan under consideration. It is an aerial jeep. This leads to the aerial sedan of the future.

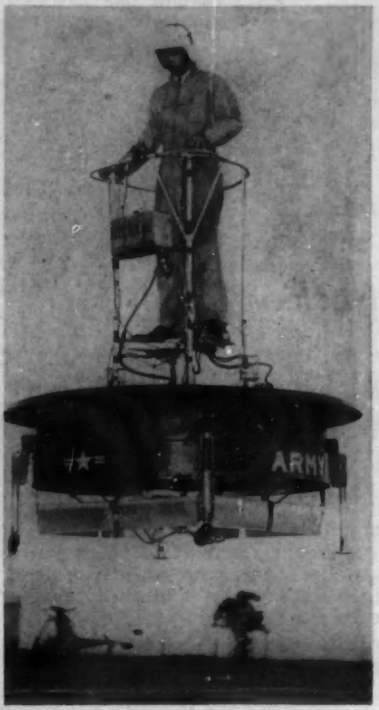

Fig. 1 — Damping vanes have been added to the Flying Platform to simplify control in flight. These vanes are controlled automatically by gyroscopic means.

Contractor Suggests Earthmover Improvements

Based on paper by

D. A. ARMSTRONG
S. J. Groves & Sons Co.

(Presented before the Earthmoving Industry Conference of the Central Illinois Section of SAE)

ONE contractor finds that new earthmoving equipment requires a greater amount of preventative maintenance and service due to increased complexity of the machines. He suggests that manufacturers consider the following in future designs:

1. Improved air filtration systems to accommodate the greater air flow required by the new higher-output engines.
2. Heavy-duty electric systems which will permit more night work.
3. Fully sealed bearings in sheave assemblies.
4. Improved plumbing systems for the transfer of air or hydraulics.
5. Improved cable and hydraulic systems.

To Order Paper No. S74 . . .
on which this article is based, see p. 5.

Continued on page 122

NUCLEAR NEWS NOTES

A feature of the **SAE Nuclear Energy Energy Advisory Committee**

Nuclear Energy Fields Show Continued Progress

Reported by

C. R. Lewis, Chrysler Corp. and **C. R. Russell,** GMC

(for the SAE Nuclear Energy Advisory Committee)

THE 1958 Nuclear Congress held in Chicago on March 17–21 showed that slow but steady progress is being made in various phases of nuclear energy, such as:

- **Building and operation of power reactors.**
- **Development of reactor components.**
- **Standardization.**
- **Thermonuclear energy.**

Power Reactors **— Within the past year, six power demonstration reactors have gone into operation — three in government laboratories and three operated by private industry — and all have met or even exceeded expectations. The ability of the Argonne boiling water reactor and the General Electric Vallecitos reactor to produce more power than expected indicates that a considerable part of the high initial cost of nuclear energy installations can be offset by better performance than had been anticipated.**

Reactor Components **— Exhibits at the Atomfair of advanced designs of fuel elements, control systems, other devices, and materials showed that the manufacture of reactor components is a large and thriving industry. Research devices that, a couple of years ago, were only available at a few laboratories can now be purchased from a catalog. Most notable of these was the subcritical reactor in operation at the International Amphitheater.**

Standardization **— Cost of nuclear components will be reduced as the extensive program on the preparation of standards and codes for nuclear power plants and their components bears fruit. This work is supported through the Nuclear Standards Board of the American Standards Association, by the several industrial societies and organizations concerned with atomic energy.**

Thermonuclear Energy **— Although a time table for self-sustaining power generation from thermonuclear energy cannot yet be estimated, recently reported results indicate that:**

- **A fruitful approach to the problem has been found.**
- **There are no insuperable barriers to the eventual production of thermonuclear power.**
- **A thermonuclear power station would probably, of necessity, be of very large size.**
- **There will still be an important place for the types of fission reactors now being developed.**

Nuclear-Powered Ships Will Come But Slowly

A report of the

SAE Nuclear Energy Advisory Committee

SHIP operators are showing a considerable lack of enthusiasm for nuclear-powered vessels. Some of the reasons were expressed at recent hearings of the House Merchant Marine and Fisheries Committee.

A proposal to build two nuclear passenger superliners — one for service in the Atlantic and the other in the Pacific — were being considered. Unanimously against the proposal were the Navy and the Department of Commerce, as well as potential operators. Their reasons covered such varied points as:

- **Cost of construction and operation would be too high to be competitive.**
- **The vessels would probably be obsolete before they were launched and would certainly be outmoded long before the end of their useful life.**
- **There is not enough experience with such ships to justify them at this time.**
- **There are still some uncertainties relating to insurance and possible hazards.**

All this, of course, is not to say that no progress is being made in this field. As is well known, the first nuclear-powered merchant vessel — the NS Savannah — is already being built and contracts have been awarded for the development of a converted tanker.

The keel of the Savannah was laid at the New York Shipbuilding Corp. yard, Camden, N. J., on May 22 (Maritime Day). Scheduled for completion in 1960, the ship will develop 20,000 shaft hp, displace 21,800 tons. It will carry 25 officers, a crew of 84, and 60 passengers. The reactor, which is to be of the advanced pressurized water type (to be built by Babcock & Wilcox), will be located amidships to centralize the great shielding weight.

Contracts for engineering, design, and cost studies on converting to nuclear power a tanker now under construction have been awarded, according to the AEC and the Maritime Administration. Under consideration for this vessel is a reactor of the boiling water type. The hull, which is now virtually completed (being built by Ingalls Shipbuilding Co.) is intended as a 22,500-ton prototype with 20,000 shaft hp. If it is decided to incorporate a nuclear reactor in this tanker, the estimate date of completion will be 1961 — a year later than the Savannah.

SAE CEP COOPERATIVE ENGINEERING PROGRAM NEWS

New Brake Fluid Spec Calls for 375 F Minimum Boiling Point

A NEW 375 F BRAKE FLUID specification has just been approved by the SAE Technical Board. Fluids made to it are intended for extremely severe service where brakes are heavily loaded, have low heat dissipation, or are applied repeatedly in hot weather. This new spec also points to the time when "metalic" linings may be used and high temperatures could be the rule rather than the exception.

Extensive industry round robin tests proved that only SAE 70R1 type fluid was safe in new cars under all expected conditions. The same tests showed that the industry would need a better than 300 F boiling point fluid in the future. The new SAE 70R3 standard is the result of the SAE Brake Fluids Subcommittee's attack on the problem.

What Do 70R3 Specs Require?

The main point of the new spec is a minimum boiling point of 375 F. However, there are three other differences between the new (70R3) and the present (70R1) standards.

The first is the recognition of synthetic cups now being used in some wheel cylinders. These GR-S cups have swelling characteristics different from natural rubber cups. The 70R3 standards calls for a rubber swell test of both types. To aid testing, standards have been set for both type of cups. The swell tolerance for natural rubber cups in a 70R3 fluid must meet the present 70R1 requirements. The maximum swell tolerance for GR-S cups has been increased from 0.050 to 0.055 in.

The second difference is an increase in minimum flash point from 145 to 180 F.

Finally, GR-S cups will be subjected to different lubricating requirements. They must undergo a stroking test of 70,000 strokes at 250 ± 5 F and 1000 ± 50 psi. Rubber cups still must pass 150,000 strokes at 158 ± 5 F and 500 ± 50 psi in 70R3 and 70R1 tests.

Tests for such items as viscosity, corrosion, boiling point change, and compatibility are the same.

The 375 F boiling point was chosen because it will solve the present temperature problems *and* it can be produced now. Not only does a new fluid have to meet the tough performance requirements of the spec but it must be compatible with the fluids already in use. This is to insure that brakes won't be plugged with a precipitate if some new fluid is added to the brake system at a service station. Also, the round robin tests showed that this temperature would cover the extreme stopping procedures the test vehicles were put through. These conditions made it impractical to jump to a higher boiling point.

WINDING UP the requirements for the new 70R3 Brake Fluid Standard are (l. to r.) Chairman F. J. Markey, S. R. Doner, and B. E. Tiffany. Helping them were G. L. Doelling, D. H. Hanson, J. E. King, H. W. Loper, R. W. Shiffler, C. M. White, and J. H. Wright who are also members of the Brake Fluids Subcommittee.

Reliable Full Trailer Safety Chains Assured

MAKERS and users of full trailers may be assured of emergency safety through use of a new SAE recommended practice. The report contains information on the number, location, methods of attachment, and capacity of safety chains. It is scheduled to appear in the 1958–1959 Handbook.

Safety Chain Capacity

The report recommends that safety chain capacity be equal to the gross vehicle weight of the full trailer on which it is used. When two chains or two cables are used, each chain or cable shall have a capacity equal to the gross vehicle weight.

A generally accepted method of calculating ultimate and yield is included in the report. It states that:

(1) Proof test load should equal the safe working load times two.

(2) Ultimate strength should equal the proof test load times two minus 10%.

(3) Chain yield should equal ultimate strength minus 10%.

The Safety Chain for Full Trailers report was developed by the Truck and Bus Technical Committee.

AMS Division Honors Chairman J. B. Johnson

A. W. F. Green · J. B. Johnson · J. B. Johnson · J. H. Dressel

MORE than 100 members and guests of the SAE Aeronautical Materials Specifications Division paid tribute to J. B. Johnson for his 17 years of leadership of the group. At a recent meeting of the AMS Division in Philadelphia, a special dinner was held in honor of Johnson and upon his retirement from the chairmanship of the Division. Shown at left is AMS Division member A. W. F. Green, who arranged the dinner program, and presented Johnson with a watch, a commemorative book of Johnson's achievements in AMS Division, and a complete up-to-date set of Aeronautical Materials Specifications.

Also shown are Johnson and incoming AMS Division Chairman J. H. Dressel. Among the guests at the dinner who paid tribute to J. B. Johnson in particular and the AMS Division in general were Admiral L. D. Coates of the Navy Bureau of Aeronautics, Colonel Harvey Huglin of the Wright Air Development Center, and 1957 SAE President W. Paul Eddy.

Nomenclature Reports Will Assure Clarity

TO ASSURE clarity and increase understanding between engineers, five new nomenclature reports will appear in the 1958–1959 SAE Handbook.

ENGINE NOMENCLATURE is applicable to all types of reciprocating engines, including four-stroke cycle, two-stroke cycle, and free piston engines. It was developed by the Engine Committee.

FREE PISTON ENGINE NOMENCLATURE lists 24 basic free piston engine definitions. It too is a report of the Engine Committee.

AUTOMATIC TRANSMISSION FUNCTIONS TERMINOLOGY is the new name of Automotive Transmission Functions. A product of the Transmission Committee, it contains nomenclature for a total of 22 items.

NOMENCLATURE — CABLE CONTROL UNITS is applicable to heavy-duty construction equipment. It was developed by the Construction and Industrial Machinery Technical Committee.

NOMENCLATURE — RIPPERS, ROOTERS, SCARIFIERS contains 17 definitions. It too is a report of the CIMTC.

Bumper Heights Studied By New SAE Committee

BUMPER heights for passenger cars, station wagons, and half-ton trucks are being studied by the new SAE Bumper Height Technical Committee. The project results from an Automobile Manufacturers Association request to incorporate new design criteria into the existing SAE Bumper Height Standard.

The new group held its first meeting in April under the chairmanship of K. A. Stonex who is assistant director of General Motors Proving Grounds in Milford, Michigan.

Lathe Cut Seal Spec To Cut Production Costs

BECAUSE lathe cut seals used in transmissions cost less to make than "O" rings or molded lip seals, a new SAE report has been developed which gives design data on both dynamic and static seals. Low cost is achieved by lathe cutting the seals from extruded tubing.

Specifically, the new report:

(1) Suggests rectangular seal ring tolerances and dimensioning practices.

(2) Outlines design criteria for dynamic seals up to 400 psi.

(3) Gives rectangular seal ring design data for static seals.

The report recommendations which were developed by the Transmission Committee are considered general. They are based on the use of such materials as Buna N or Polyacrylate type rubber in the 50–80 durometer range.

The report will appear in the 1958–1959 SAE Handbook.

News Briefs of SAE-ASTM Automotive Rubber Group

THE following result from a spring meeting of the SAE-ASTM Technical Committee on Automotive Rubber.

ISO PROPOSAL FOR SINGLE INTERNATIONAL RUBBER CLASSIFICATION VOTED DOWN—The TCAR voted against the latest International Standards Organization proposal (ISO-TC-45) for a single document which would contain all international rubber classifications. The vote, which was requested to guide American delegate Dr. R. D. Stiehler, National Bureau of Standards, was submitted on the following grounds: It—

(1) Promotes specifying impossible combinations of properties.

(2) Fails to give consumer guidance on properties and elastomeric compositions that are commercially available.

(3) Is more cumbersome and difficult to use than the U.S. tabular system.

EXPANDED TABULAR SYSTEM DRAFTED AS ONE SPEC — The proposed expanded tabular system which combines existing SAE 10R and ASTM D-735 tables into a single specification is now available in draft form from T. M. Loring, Chicago, Rawhide.

The new specification consists of two tables: One combines all current basic tables, the other all current suffix tables. For the most part, existing values for each class of compound are retained.

The new system offers a more flexible way to incorporate new polymers and polymer blends. In addition, TCAR members feel it may be the start of an era when the customer can indicate more closely his actual needs.

HIGH AROMATIC FUELS SLATED FOR FUTURE TESTS — Only high aromatic fuels will be used in future TCAR studies of fuel-rubber compatibility. Because preliminary tests show that high aromatic fuels have a more significant effect on rubber hardness, tensile strength, and volume change, the committee has decided to limit future testing to fuels having a 50% or above aromatic content.

Two rubber compounds from Class SB and two from Class SC of the SAE-ASTM tables are being tested with two different fuels having the following content:

Iso-octane, %	50	50
Benzene, %	—	10
Toluene, %	50	20
Xylene, %	—	20

COMPRESSION SET TEST TIME SHORTENED BY 48 HOURS — An analysis of recent data on SAE 415, 515, 615, 715, and 815 compounds indicates the practicality of shortening the current test time from 70 hr to 22 hr. This would apply to Classes SB and SC for both basic and suffix B requirements.

The compression set test on Class SC compounds now run for 22 hr at 158 F will be changed to 22 hr at 212 F.

IMPACT TEST EQUIPMENT PROPOSED — Ideally, impact test equipment should be small, compact, inexpensive, and designed to measure durability of a small rubber specimen subjected to repeated impacts. A set of broad specifications based on these conditions has been prepared by the TCAR which is now working on a schematic drawing of suggested equipment.

TEAR TESTING — As a result of an analysis of recent data on commercial compounds of various hardnesses and tensile strengths, minimum values for tear resistance using Die B have been tentatively agreed on for hardnesses of 50, 60, 70, and 80 in three tensile ranges: 1000 to 2000 psi, 2000 to 3000 psi, and above 3000 psi (natural rubber black compounds).

Technishorts . . .

A VEHICLE COOLING ABILITY TEST CODE is being developed by the Test Codes Subcommittee of the Construction and Industrial Technical Committee. The code is needed to determine if engines, as installed in vehicles, provide the cooling necessary for operation under extreme conditions, according to Subcommittee Chairman A. J. Rutherford.

FIVE TRACTOR TIRE PROBLEMS — will be tackled by the Tractor Tire Subcommittee which is being reorganized by the Tractor Technical Committee, according to TTC Chairman I. F. MacRae. The items which follow are slated for subcommittee consideration.

(1) Need for a uniform tire test code.

(2) Need for more information on tire torque capacities.

(3) Simplification of present and future tire specifications.

(4) Development of uniform dynamic rating of tractor tires.

(5) Need for a tire list which would make adequate provision for future design requirements.

Technical Committee Profile . . .

Dr. Molloy

AIRCRAFT DESIGN ENGINEERS who are *not* vibration experts will soon have access to a report on how to design vibration isolation systems into future aircraft. The prime purpose being . . . to keep complex electronic equipment from 'going out of wack.'

Based on Sophisticated Theory

The performance equations under development are based on sophisticated vibration theory according to Lockheed's **Dr. Charles Molloy**, chairman of SAE Committee S-12 on Shock and Vibration. Currently, S-12's four subcommittees are working these equations into actual design procedures. Emphasis is being placed on the development of a graphic means for achieving this end.

Specifically, the designer will be told:

- What basic information is necessary.
- How to use the prescribed performance equations.
- Whether an isolation system is needed.
- How to execute and check designs.

Explains How, Not Why

The document will be a straightforward statement of what to do, not why it is done. Dr. Molloy indicated that appendixes explaining the theories on which the document is based will be prepared upon completion of the main report, which is likely to appear as a new ARP.

Because the work of the committee has required a certain amount of actual development work, S-12 instituted a new type of meeting called 'a work session.' At these sessions, participants concoct and try design techniques. Dr. Molloy said that, in addition to regular committee and subcommittee meetings, two extremely productive work sessions have been held to date. He hopes to be able to schedule them as frequently as once a month in the near future.

About SAE Members

EARLE S. MacPHERSON has retired as vice-presdent advising on engineering policies for Ford Motor Co. He first entered the auto industry in 1915, and joined Ford in 1947.

EDWARD C. WELLS, vice-president — engineering, Boeing Airplane Co., heads the newly organized Systems Management Office, which will have responsibility for development and management of the comprehensive weapons systems of the future.

CHARLES F. HAMMER has been appointed vice-president — engineering, for the Air Brake Division of Westinghouse Air Brake Co. Prior to this he was director of engineering with the division.

CHARLES W. DUFFY has been elected vice-president and director of the Standard Products Co., in Cleveland. Prior to this he had been with the Kelsey-Hayes Co. in Detroit as sales engineer and advertising manager.

HARRY S. PACK, vice-president and former director of customer relations for Vertol Aircraft Corp., is now head of the newly created International Division of the corporation. He has been associated with Vertol since 1945.

ALEXANDER DREISIN has joined the Allis-Chalmers Mfg. Co., Harvey Works, Harvey, Illinois, as chief engineer of the newly organized Allis-Chalmers Diesel Fuel Systems Department. For the past four years he has been chief engineer of the Micro-Precision Division of the Micromatic Hone Corp.

GEORGE W. BROWN has been elected executive vice-president of the Wagner Electric Corp. He joined the corporation in 1926 and was vice-president prior to his new appointment.

PAUL C. FORD was elected vice-president in charge of engineering and research for Wagner. Hė has been with the corporation since 1937 and most recently was executive engineer directing automotive and electrical engineering and research facilities.

In the National Malleable and Steel Castings Co., **B. C. YEARLEY** has been made assistant vice-president. He joined the company in 1924 and most recently has been assistant to the vice-president.

WILSON H. MORIARTY will be the chief executive officer of the newly-formed Railway and Mine Division. He continues his staff duties as first vice-president of the company.

KENNETH SELBY is now vice-president — engineering, with the Railway and Mine Division. He has been in charge of the Technical Center in Cleveland since 1948, when he was made chief engineer — Railway Division.

MARK MILLER has become vice-president — Sales, Industrial Division. He has been with National since 1941 and most recently was assistant to the vice-president in charge of sales.

JOHN F. ADAMSON has been made assistant chief engineer of the Automotive Division of American Motors Corp. He joined Nash Motors in 1947, and was staff assistant to the director of engineering prior to his new appointment.

Adamson replaces **J. S. VOIGT**, who has retired after 14 years of service with the company.

HAROLD M. HARRISON has been named assistant chief engineer for the California Division of Lockheed Aircraft Corp. He has been with Lockheed since 1939, and most recently was chief systems development engineer. Harrison has served as 1956–57 SAE vice-chairman representing aeronautics, for the Southern California Section.

J. H. OVERHOLSER, formerly assistant general manager with Pacific Division of Bendix Aviation Corp., is president of the newly formed Hydrodyne Corp.

ROBERT T. SKINNER, owner and manager of the Skinner Seal Co., is executive vice-president of Hydrodyne.

ARTHUR J. WELCH has been made vice-president and general manager of the Spring Division of Borg-Warner Corp. He has been associated with the division since 1942 and was vice-president and assistant general manager prior to his new assignment.

MELVIN J. OLSON, formerly layout designer for the LeTourneau Westinghouse Co. in Peoria, Ill., is now with the Northwest Engineering Co. in Green Bay, Wis., as engine application engineer. He has been active in SAE Central Illinois Section on the Governing Board.

WARREN C. REYNOLDS, formerly research engineer, gas turbine department, Ford Motor Co., is now a development engineer, turbochargers, with Thompson Products, Inc. He is presently designing a turbine test dynamometer to be used in turbocharger development.

MacPherson

Wells

Hammer

Duffy

Pack

Dreisin

WILLIAM B. PROSSER, president of Perfect Circle Corp., has been elected to the board of Aluminum Industries, Inc.

EARLE R. KLINGE is now manager, advanced truck engine and driveline engineering department, Ford Division, Ford Motor Co. Formerly he was assistant chief engineer, diesel, with Continental Aviation and Engineering Corp.

Klinge is currently a member of SAE Diesel Engine Activity Committee for 1958.

HAROLD F. WOOD, executive vice-president of Wyman-Gordon Co., will act as vice-president of the newly formed H. F. Wood Co. He will serve the firm in an advisory capacity with emphasis on consultation.

KENNETH J. BOEDECKER has retired as staff assistant to the vice-president, sales, Wright Aeronautical Division of Curtiss-Wright Corp. He is now engaged in consulting work.

ROBERT J. LIGGETT has been elected vice-president and director of Tiona Petroleum Co. Formerly he was a chemical engineer with the company.


Brown


Ford


Yearley


Moriarty


Selby


Miller


Adamson


Harrison


Overholser


Skinner

HOWARD C. BEYER has joined Jeta Metal Fabricators, Inc., in Yonkers, N.Y., as general manager of the company's newly organized Power Equipment Division. Formerly he was executive vice-president of International Fermont Machinery Co., Inc., in Ramapo, N.Y.

DR. ERNEST F. FIOCK has been named chief of the research section, engineering and development department of the newly formed Astrodyne Co. The company is under the joint equal ownership of Phillips Petroleum Co. and North American Aviation, Inc. Fiock will be in charge of Astrodyne's solid propellant and propellant process laboratories and the fundamental studies group. Prior to this he was director, technical development branch, Rocket Fuels Division, Phillips Petroleum Co.

CHARLES H. DAWSON is now general manager of Calwin Equipment Rentals Ltd., in Calgary, Alberta, Canada. Formerly he was Calgary manager of the Wilson Equipment Co., Ltd.

MAHLEN F. KAHLER has become staff industrial engineer, Boxboard and Folding Carton Division, Robert Gair Paper Products Group, Continental Can Co., Inc. Previously he was in the Industrial Engineering Department of Deere & Co.

RICHARD R. STAEBLER is now chief engineer, petroleum tanks, with the Heil Co., in Milwaukee, Wis. He has been with the company for seven years and was product engineer in the Hillside, N. J. plant prior to his new position.

DONALD G. HUBBARD has accepted a position as mechanical engineer at the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va. He will work as a project engineer in the engine test laboratory of the Evaluation Engineering Branch, Mechanical Engineering Department. Hubbard was a product design engineer with the Ford Motor Co. prior to his new position.

HAROLD C. MOODY, formerly special projects engineering manager for Avro Aircraft, Ltd., in Toronto, is now self employed in sales of automotive and aircraft products in Spokane, Wash.

PAUL B. BEST, JR., formerly with the O. A. Sutton Corp. as sales manager in the Original Equipment Division, is now vice-president and part owner of the RC-Nehi Bottling Co., Inc.

HARRY BAUM is now style editor for the McGraw-Hill Encyclopedia of Science and Technology, Charlottesville, Va. Previously he was project manager of the McGraw-Hill Technical Writing Service in New York City.

DONALD G. HUBBARD, formerly with Ford Motor Co. as product design engineer, is now a powerplant engineer with the Engine Test Laboratory, Evaluation Engineering Branch, Engineer Research and Development Laboratories, in Ft. Belvoir, Va.

WILLIAM A. KELLEY is now with the Wooster Division of Borg-Warner Corp. as a project engineer engaged in engineering design on fuel injection systems. Prior to his new position he was manager of the Detroit office of Simmonds Aerocessories, Inc.

PETER A. THOR, JR., is now with the Chevrolet Division of General Motors Corp., as layout man, engine design group. Formerly he was a design engineer with the Scott-Atwater Mfg. Co. in Minneapolis.

RAY MATLOCK is now a vice-president and partner in the William G. Mays Co. in Garland, Tex. Prior to this he was sales engineer with the Wright Aeronautical Division of Curtiss-Wright Corp.

LESTER G. BELTZ has joined the Electric Auto-Lite Co. as sales representative in the Die Cast Division. Prior to this he was a manufacturing engineer in prototype build-up, Hardware Division of the Ford Motor Co.

CLAUDE H. MAY is now with the Walker Mfg. Co., of Wisconsin as advanced projects engineer. Previously he was with the Ford Motor Co., as a project engineer, Advanced Mercury, engineering staff.

DOUGLAS M. PARK, formerly vice-president of the Wallace Barnes Co., Ltd., in Hamilton, Ontario, Canada, is now a purchasing agent for the Barnes Gibson-Raymond Division of Associated Spring Corp.

WILLIAM E. JOLIN, JR., formerly project engineer for Stratoflex, Inc., in Ft. Worth, Tex., is now a project engineer on controls for the Bryant Mfg. Co., Division of Carrier Corp., in Indianapolis, Ind.

THEODORE S. MOISE, III, has become a development engineer for the Eastman Kodak Co. Formerly he was electronics officer, VF 101, U.S. Navy.

FRED C. RUNFOLA is now with O. E. Szekely and Associates, Inc., Commerce, Ga., as operations coordinator. Previously he was with the Glen L. Martin Co. in Baltimore, Md., as logistics planning supervisor and weapons systems evaluation specialist.

HAROLD W. ROYL, formerly general sales manager for Canadian Curtiss Wright, Ltd., in Montreal, is now in the same position with the Curon Division of Curtiss-Wright Corp. in Quehanna, Pa.

CHARLES F. McELWAIN, formerly general manager, Military Products Division, IBM Corp., is now director of manufacturing for IBM World Trade Corp. He directs operations at eighteen locations around the world.

WERNER MUNZ is now senior test engineer for Mack Trucks, Inc. in Allentown, Pa., where he is engaged in experimental frame stress analysis. Formerly he was a test engineer with the Chevrolet Division of General Motors Corp.

JOHN R. SMYTH, former chief control engineer, has been named to the newly created post of assistant director of engineering at Exide Industrial Division of the Electric Storage Battery Co.

CONTINUED ON NEXT PAGE


Frankel


Molnar


Nordstrom


Shoemaker


Laird


Watson


Johnson

DONALD P. FRANKEL has joined Chicago Aerial Industries, Inc., as director of customer relations. Prior to this he was with Marquardt Aircraft Co., in Van Nuys, Calif., as assistant director in the Customer Relations Division.

JAMES L. MOLNAR has become assistant body engineer — production, in the Automotive Division of American Motors Corp., with headquarters in the company's main body plant in Milwaukee. He has been with AM since 1952, and formerly was a project engineer with the company in Detroit.

WILBUR C. NORDSTROM has been elected vice-president — manufacturing for the Standard Products Co. He has been with the company since 1950 and was general manager of manufacturing prior to his new appointment.

LORING F. SHOEMAKER, of Allis-Chalmers Mfg. Co., was elected president of the Internal Combustion Engine Institute at the annual meeting in March.

HENRY H. HOWARD, of Caterpillar Tractor Co., has been elected treasurer of the Institute.

WILSON LAIRD, vice-president in charge of advanced planning and government relations for The New York Air Brake Co. has been appointed to the Board of Governors of the Aircraft Industries Association.

CARL E. WATSON is now technical assistant to the manager of the Petroleum Products Research Division at the Richmond Laboratory of California Research Corp. Previously he was division supervisor, Grease and Industrial Oil Research, with the corporation.

WILLIAM R. JOHNSON has been appointed assistant director of research and development for Associated Spring Corp. Formerly he was chief research metallurgist at the corporation's research center in Bristol.

ALBERT M. CURRIER, JR., has been named general manager of Clevite Service, the replacement parts marketing organization of Cleveland Graphite Bronze Division, Clevite Corp. Currier, formerly Clevite Service sales manager, has been with the organization since 1946.

JOHN WALDHERR, JR., is now with the Wells Mfg. Co., Fond Du Lac, Wis., as chief engineer in the Fuel Pump Division. Prior to his new position he was director of engineering, Airtex Products, Inc., in Fairfield, Ill.

CMDR. HARRY J. HUESTER, USNR, is now a government contact representative, engaged in consulting and technical services in Arlington, Va. Formerly he was deputy director, Aeronautical Structures Laboratory, Department of the Navy, Naval Air Materiel Center, U.S. Naval Base in Philadelphia.

JENNINGS ANDERSON has become vice-president and general manager for the Gunn Oldsmobile Co.; prior to this he was assistant sales manager for Gunn Oldsmobile, Inc.

WILLIAM G. ZORN has become performance engineer with the LeTourneau Westinghouse Co.; formerly he was design engineer with the company. Zorn has been active in SAE Central Illinois Section as 1957-58 publicity chairman.

DUNCAN H. STODDARD is now with Wheeling Pipe Line, Inc., as superintendent of equipment. Prior to his new position he was with Arkansas-Best Freight System, Inc., in the same position; he had been with the corporation for five years.

NILS A. THUNSTROM, formerly chief engineer for the Greyhound Corp., is now assistant director of equipment with the corporation. His duties include the investigation of and determination of technical solutions to defects in equipment.

WILLIAM CLAY FORD has been named a director of the National Tennis Hall of Fame. He has played an important role in furthering junior tennis activities in the United States for a number of years.

Two new sales managers have been appointed by the Eclipse Machine Division of Bendix Aviation Corp.

ROBERT K. GORNALL is now sales manager of carburetors with headquarters in Detroit; **JOHN A. RIOPELLE** has become sales manager of fuel nozzles in Elmira.

Gornall, formerly assistant sales manager of carburetors, has been with the division since 1948. Riopelle joined the division in 1952 and was a sales engineer in the Detroit office prior to his new appointment.

EDWARD W. HUFNAGLE has been appointed assistant manager, automotive sales, for the Glass Division of Pittsburgh Plate Glass Co. He will have headquarters at the firm's Detroit office. Hufnagle joined the product development department of the company at Pittsburgh in 1945, and has served as industrial sales engineer at Detroit since 1951.

CLIFFORD F. HOOD, president, United States Steel Corp., spoke on "Dollars and Common Sense" at the annual banquet of the Blue Valley Manufacturers' and Business Men's Association, April 17, in Kansas City, Mo.

GORDON STEINHOFF, formerly manager of the Aircraft Division of General Controls Co., now heads the newly organized Engineering Division of Allan Aircraft Supply Co.

In the Delco-Remy Division of General Motors Corp., **JOHN D. BAKER** has become assistant general sales manager responsible for planning and direction of original equipment sales activities; **FORREST A. STINSON** is now manager of Detroit regional sales.

Baker, associated with the division since 1940, was assistant sales and service manager prior to his new position.

Stinson began his career with the division in 1926 as a cooperative student and was sales engineer prior to his new appointment.

WILLIAM P. DUGAN has become manager of the sales service section, Research and Development Division of Sun Oil Co. He joined the company in 1946 and was with the automotive laboratory prior to his new appointment.

In the same division, **DR. PAUL E. OBERDORFER** is manager of the petrochemicals section. He has been a research chemist in the fuel development section since joining the company in July, 1955.

ERIC A. MEYER, formerly an engineer with the Carrier Corp. in Syracuse, N.Y., is now with Dunham-Bush, Inc., in West Hartford, Conn., as sales engineer, Export.

EARLE A. RYDER, aircraft industry consultant, has received the 1958 ASLE National Award for his contributions to lubricant evaluation. The award signifies honorary life membership in the American Society of Lubrication Engineers.

S. A. MALTHANER, formerly chief engineer of the Automotive Division with Gunite Foundries Corp., will now direct engineering for all company products.

DONALD B. MORSE, formerly sales manager, Scintilla Division of Bendix Aviation Corp., is now director of sales, service and advertising. He has been with Scintilla since 1941.

AMBROSE J. ILG is now with Southern California Freight Lines in Los Angeles as maintenance director. Prior to this he was garage manager for Roadway Express, Inc., in Akron, Ohio.

SAE Members Promoted in Chrysler Executive Changes


Row


Newberg


Bright


Woolson


Chesebrough


Bird


Anderson


Loofbourrow

SAE members involved in "important and significant developments in the organization structure and executive management" of Chrysler Corp., announced by Chrysler President **L. L. COLBERT**, included the following:

E. C. ROW becomes First Vice-President and Chairman of the Administrative Committee;

WILLIAM C. NEWBERG has been named Executive Vice-President.

In addition, operating through three new groupings of functions at the corporate level:

R. S. BRIGHT becomes Group Vice-President — Automotive Manufacturing, and

IRVING WOOLSON becomes Vice-President, Director of Manufacturing Services.

Reporting to the newly-created Group Vice-President of Automotive Sales:

HARRY E. CHESEBROUGH who has been elected a Vice-President of Chrysler Corp., becomes General Manager of Plymouth;

WILLIAM J. BIRD has been named Executive Assistant to the Group Vice-President — Automotive Sales.

Under a new Vice-President — Corporate Planning Staff:

ROBERT ANDERSON has been named Director of Product and Volume Planning.

. . . and under Vice-President — Engineering **PAUL C. ACKERMAN**:

A. G. LOOFBOURROW has been named Director of Engineering.

. . . and under Group Executive-Car & Truck Assembly.

F. L. BIRD is now plant manager, Chrysler-Jefferson and Kercheval plants;

G. T. POIRIER is plant manager of the Imperial-Warren plant.

ALVIN M. FISCHER, formerly sales engineer with the Bendix-Westinghouse Air Brake Co., is now with Mack Trucks, Inc., as a project engineer.

THOMAS B. WAKELAND, formerly district sales engineer for the Link-Belt Co. in Chicago, is now regional sales engineer with the Hoover Ball & Bearing Co. in Ann Arbor, Mich.

IRVING SOCHRIN has become a source inspector with Combustion Engineering, Inc., in Windsor, Conn. Previously he was with the Wright Aeronautical Division of Curtiss Wright Corp. as a field engineer. His new position includes investigation and evaluation of sub-contractors' methods of manufacture.

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SAE Staff Appointments

Marble Roop

WILLIAM I. MARBLE and **JOHN M. ROOP** are assuming new responsibilities on the SAE staff. Marble has been promoted to assistant manager of the Engineering Activities Division. Roop joined the staff in April to carry on the work in the Technical Committee Division that Marble has been handling.

Roop comes to SAE from the Ford Division, Ford Motor Co., where he was a service engineer and a quality control analyst. Previously he worked for Chrysler Corp. as a product engineer at the Chrysler Jet Engine Plant. He received a B.S. degree in Mechanical Engineering from Michigan State and has done graduate work at Wayne State University in business administration. While serving in the USAF as a 1st lieutenant he was in charge of ground vehicle equipment maintenance.

READ LARSON, formerly assistant to the technical director, refinery chemicals department, American Cyanamid Co., is now a sales engineer with Amoco Chemicals Corp., in Chicago.

JAMES E. GAUSE is now an engineer, junior, in the Ordnance Division of Westinghouse Electric Corp. in Baltimore, Md. Formerly he was a graduate student at the Westinghouse Education Center in Pittsburgh, Pa.

ERNEST G. DAVIS is now contact engineer, engine and transmission section, Edsel Production Product Engineering, M-E-L Division of Ford Motor Co. Formerly he was production contact engineer with the Edsel Division of Ford.

HERBERT G. WHITE, formerly a project engineer for the Rochester Products Division, General Motors Corp., is now contact engineer with the division.

HOWARD D. PLUMLY, formerly chief chemist with the Baltimore & Ohio Railroad Co., is now technical sales engineer with the National Refining Co. in Chicago.

WALTER H. NIEDERMEIER, formerly assistant lubrication manager, Shell Oil Co., in Flushing, N.Y., is now with the St. Louis Division of the company as manager — industrial products.

ILIA I. ISLAMOFF is now with the Hayes Aircraft Corp., in Birmingham, Ala., as engineer, design "A". Prior to this he was vice-president — engineering, quality and security, with the Ludwig Honold Mfg. Co. in Folcroft, Pa.

MADISON POST, formerly executive officer, U.S. Army Ordnance Tank — Automotive Command, Field Service Division, in Detroit, is now with the Allis Chalmers Mfg. Co., Springfield Works, as engineer, assistant to the chief of experimental development.

IRWIN A. BINDER has become vice-president, manufacturing, for the Ramo-Wooldridge Corp. in Los Angeles, where he will be responsible for coordinating all manufacturing efforts involving both commercial and military products. He had been with Thompson Products, Inc. since 1930, and most recently was assistant general manager at the Tapco Plant in Cleveland.

DR. CHARLES S. DRAPER, professor and head of the department of aeronautical engineering at the Massachusetts Institute of Technology, is among a group of leading scientists who have been retained as consultants by Republic Aviation Corp. He will be on the research staff in development of manned aircraft and missiles of supersonic and hypersonic design.

DEAN B. HAMMOND has been made vice-president — engineering for Willys Motors, Inc. He has been engaged in consulting work for the past two years.

Among industrial leaders who received the Twelfth Annual Horatio Alger Awards on May 8 were **JAMES H. CARMICHAEL**, chairman of Capital Airlines, and **T. CLAUDE RYAN**, president and director of Ryan Aeronautical Co.

HUGH D. LOWREY, former manufacturing director in the Defense Operations Division of Chrysler Corp., is now director of operations. **BERNARD J. MELDRUM**, formerly business management branch manager, has become special assistant to the general manager.

HALSEY W. WILLS has retired as eastern manager of the King-Seeley Corp., after service of 35 years.

DR. SIDNEY M. CADWELL has retired as director of research and development for United States Rubber Co. He has been in this position since 1946, and is the holder of 69 patents.

JOHN N. LYNDALL, JR. has become superintendent of maintenance for the Hertz Corp. Prior to this he was a radar engineering technician for the Bendix Radio Division of Bendix Aviation Corp.

WILLIAM B. GRIPE, formerly project engineer for Hall Scott, Inc., Berkeley, Calif., is now a product engineer for Curtiss-Wright Corp. in South Bend, Ind.

PAUL E. TOBIN, formerly vice-president, sales, for The White Motor Co. in Cleveland, is now chairman of the board and executive vice-president of Graham Motor Sales Co. in Bloomington, Ind.

JAY C. BELL, formerly senior research engineer, mechanical engineering department, engineering research office of Ford Motor Co., is now senior design engineer for the company in the Ford car engine and driveline department, Ford Division.

JOHN Y. WONG is now an engineer with the Transport Division of Boeing Airplane Co. in Renton, Wash. Formerly he was a draftsman with Hall-Scott Inc. in Berkeley, Calif.

ROBERT H. SHENK has been appointed vice-president and technical director of overall operations for Zurn Industries, Inc., including the Research and Development Division. Formerly he was with the Wiedemann Machine Co., engineering, as chief engineer.

Obituaries

CLYDE H. BRITTEN . . . (M'39) . . . vice-president in charge of manufacturing and a director of the Lubrizol Corp. . . . associated with the Shell Oil Co. for 18 years . . . joined Lubrizol in 1947 . . . died April 5 . . . born 1905 . . .

OTTO J. DOEPEL . . . (M'26) . . . sales engineer, Allied Screw of Dixie . . . had been with the company since 1956 . . . previously a purchasing agent for Metal Products Corp. and Metal Screw Corp. . . . died March 27 . . . born 1887 . . .

GEORGE T. MOORE . . . (A'20) . . . vice-president and sales manager, Wisconsin Axle Divison, Rockwell Standard Corp., (formerly Rockwell Spring and Axle Co.) . . . joined Wisconsin Parts Co. in 1919, later became vice-president and sales manager of Wisconsin Axle Co., now a division of Rockwell . . . died March 17 . . . born 1895 . . .

JOHN R. STEARNS . . . (A'40) . . . sales engineer, Eaton Mfg. Co. . . . had been with the company since 1933 . . . died April 3 . . . born 1911 . . .

Briefs of SAE PAPERS

Continued from page 6

Limited Slip Differentials, R. P. LEWIS, L. J. O'BRIEN. Paper No. 29B presented Mar. 1958, 18 p. Conventional differential and limited slip differential for passenger car and truck applications; characteristics of five limited slip differentials available, two of cam, two of friction and one of variable velocity gear type; loading and forces encountered and amount of load multiplication; design, application, and accomplishments of Powr-Lok differential, manufactured by Dana Corp.

Station Wagon Styling, D. C. WOODS. Paper No. 27A presented Mar. 1958, 4 p. Existing models on American market and foreign imports from Germany and Italy, analyzed with regard to trends; differences considered as to door arrangements, rear end design, etc.; interior and trim materials; possible station wagons of future will be designed for carrying capacity, appearance, dependability and ruggedness; they could be of small rear engine type, pickup truck variation or have club car seating.

Station Wagon Market Penetration and Its Trends, G. H. BROWN. Paper No. 27B presented Mar. 1958, 7 p. Steady increase in penetration of station wagon in mix of domestically produced automobiles, noted; data available suggests that they are bought by younger families above average income and only 1/6 belong to suburban families; data on use to which station wagons are put; factors in anticipated future increase of sales.

Development and Advantages of Tilt Cabs — Engineer's Analysis, R. H. COOK. Paper No. 26A presented Mar. 1958, 13 p. Transformation in highway and city delivery transport, summarized with reference to various forms of commercial vehicle designs affected by legal limitations set up by states and new federal highway system; typical cab and sheet metal arrangements which best meet needs of operators, advantages of tilt cab COE-vehicle (cab-over-engine configuration).

Effect of Engine Mounting on Car Shake, L. M. MORRISH. Paper No. 25C presented Mar. 1958, 10 p. Engine mountings exercise considerable control on car shake, provided that other major shake-affecting components are designed within reasonable limit from optimum; considerations of shaker imposed vibrations in laboratory; stroking machines to determine dynamic rate and hysteresis of spring members; Buick mount testing machine for determination of dynamic rate and efficiency of mounts; effects of tuning and damping.

Simulating Road Shake in Laboratory, K. P. PETTIBONE. Paper No. 25B presented Mar. 1958, 6 p. Before investigating car shake in laboratory, shake measurements are made on road, which indicate areas to investigate; setup to investigate torsional and bending shake; methods used to attack vibration problems; it is shown that "detuning" natural frequency of torsional shake from suspension frequencies may be more important than detuning bending frequencies.

Investigation of Control of Tire Thump by Tire Shape, G. J. SANDERS. Paper No. 25A presented Mar. 1958, 9 p. Testing and procedure used to find source of thump and two modes of vibration, namely circular and diametrical mode; determination of frequencies; it is shown that criteria for minimum thumps is to have shape and construction of tire which does not permit coincidence of two natural frequencies with two revolution rate harmonics in 20 to 35 mph speed range.

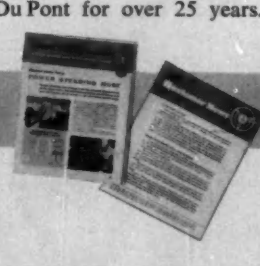
Designer's Trial "Long Clean Life or Death by Burning Oil", J. F. GREATHOUSE. Paper No. S59 presented Feb. 1958 (Metropolitan Sec) 11 p. Discussion of 18 items which are desired by today's automotive diesel engine users; points include lower first cost, no maintenance or service, long service life, reliability, simplicity of operation, insensitivity to fuel variation and minimum fuel consumption, elimination of corrosion, weightlessness, etc.; how demands are met by designers.

Design Features of New Continental 750 Horsepower Diesel Engines, H. H. HAAS. Paper No. S55 presented Dec. 1957 (Metropolitan Sec) 24 p. Trends and problems in design of 4-cycle, high performance Diesel engines in 600 to 1000 hp range; basic design features of new 750 hp air cooled engine explained with particular reference to high performance requirements; one Russian and two German diesel engines are shown to illustrate various design approaches; future outlook.

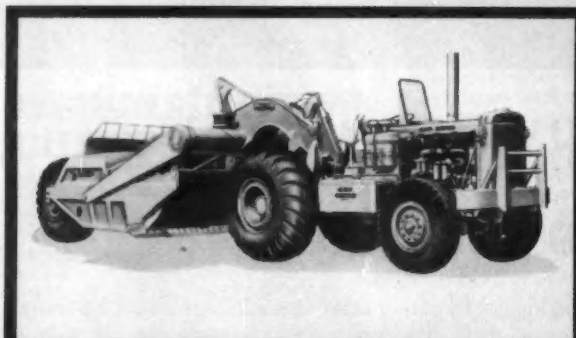
Accomplishments and Possibilities of Turbocharged Automotive Diesels, B. LOEFFLER, M. C. HORINE. Paper No. S53 presented Dec. 1957 (Southern Calif Sec) 14 p. Benefits of turbochargers and their limitations; turbocharger installations as compared with unsupercharged automotive diesels show rise in brake mean effective pressure from 108 to 140 lb per sq in., weight per hp reduction from 12 lb to 9 lb and hp per cu in. displacement up from 0.25 to 0.37; problem of exhaust connections; turbocharger installations on truck engines shown.

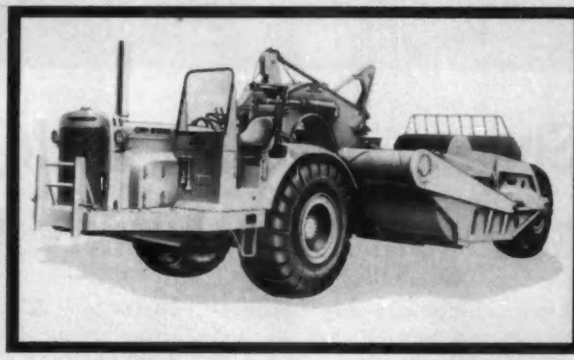
New Technique for Diagnosing Engine Troubles, N. A. ACCARDO, E. E. ECKLUND. Paper No. 21B presented Jan. 1958, 9 p. Equipment developed

Continued on page 119



NEW!
AIRESEARCH CONTROL SYSTEM SUPER-TURBOCHARGES CATERPILLAR DW20 AND DW21 TRACTORS





New AiResearch Pressure Ratio Controls *substantially increase lugging ability and travel speed* of Caterpillar DW20 and DW21 Wheel Tractors equipped with AiResearch T-15 Turbochargers.

The new control unit more than doubles the torque rise, giving the tractor greater lugging ability when operating under heavy loads. Accurate control of turbocharger speed over a wide range allows the engine to operate efficiently regardless of its changing load requirements.

This further improves other performance characteristics: *decreases specific fuel consumption ... improves acceleration ... provides cooler engine operating temperatures ... reduces smoking.* The improved air induction system also provides equal rimpull for the new DW20 and DW21 at *10% higher* travel speeds.

The two components of the new AiResearch Pressure Ratio Control unit are a pressure ratio sensor and exhaust by-pass valve. They allow the turbocharger to operate at maximum boost pressure over a wide range of engine speeds and operating conditions, thus maintaining turbocharger speed, and hence engine air input, at higher levels while lugging. This improves the overall performance match of a free-floating turbocharger.

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS

Continued from page 116

by Du Mont Laboratories is made possible by, and used in conjunction with, cathode-ray oscilloscope; Type 2900 Valve Testing Pickup is pressure/vacuum device which connects to engine in same manner as vacuum gage; Type 2903 Timing and Advance Pickup uses photoelectric principle; Type 2902 Flame Pickup; Type 2901 Noise and Vibration Pickup for detecting detonation.

Truck Performance — Computed Versus Measured Data, A. F. STAMM. Paper No. 21A presented Jan. 1958, 18 p. Results of tests on four vehicles compared with predictions from TR-82 (SAE Technical Report, "Truck Ability Prediction Procedure"); analysis of tabulated test data leads to following conclusions: valid separation of air and rolling resistance was not accomplished; effect of wind velocity and direction on air resistance may be significant; chassis friction power appears to be roughly related to engine RPM.

Imported Car Sales in United States — Study of Past and Future, W. T. CONRAD. Paper No. 20E presented Jan. 1958, 5 p. Information concerned mainly with small economy cars which represent 80% of total market; marketing system since 1948 which is first significant year in imported car sales; 2700 foreign car dealers in United States, with 50% of them located in California, New York, Massachusetts, New Jersey and Pennsylvania; parts and service problems; 200,000 imported cars sold in 1957.

Trend Toward More Intelligent Motoring — Changing Factors in Personal Transportation, J. W. WATSON. Paper No. 20C presented Jan. 1958, 29 p. Registration summary by cylinder groups in first 9 mo of 1956 and 1957; changing pattern of car use, with rapid growth of population of suburban areas pointed out as most noteworthy factor; money spent for new car purchases and for car operation in 1955 and 1956; trend in many families toward second car and growing respect for smaller European cars; lighter weight more economical cars discussed.

Small Cars — Fad or Fixture? R. SHEEHAN. Paper No. 20A presented Jan. 1958, 6 p. Comments by Fortune reporter after interviewing U S managers for foreign car manufacturers, foreign car dealers, and survey among 200 representative small car owners; increase of sales of foreign cars since 1954; contradictory opinions of big car manufacturers and small car dealers; replies to questionnaire by small car owners owning Volkswagen, or Renault, British Ford, Hillman, Simca, etc; people who buy small cars, and their reasons for doing so.

Flange Loadings in Flange Design and Gasket Selection, E. M. SMOLEY. Paper No. 13A presented Jan. 1958, 7 p. Procedure for estimating gasket loads in current flange designs; minimum sealing loads for gaskets representative of those used in field of low internal pressures; use of data for purposes of flange design or gasket selection.

MATERIALS

Quality of Decorative Plating, D. M. BIGGE. Paper No. 22A presented Jan. 1958, 9 p. Service performance of plated parts on automobiles; problems which complicate writing of specifications insuring satisfactory service performance; problems related to production of quality parts including purchasing, limitations of plating equipment, designation of points where thickness of plating is to be determined, design of part and unreliability of accelerated tests now used to predict service performance.

Accelerated Testing Developments, W. L. PINNER. Paper No. 22B presented Jan. 1958, 8 p. Reference made to previous paper (n 132) on testing plated coatings of automobile parts, indexed in Engineering Index 1957; history of development of accelerated testing procedures; acetic acid modification of salt spray test; method for evaluating test results; Corrodkote test procedure; problem of standardiza-

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tion and calibration of two test procedures.

Developments in Decorative Plating, C. H. SAMPLE. Paper No. 22C presented Jan. 1958, 14 p. Review of developments in decorative metallic finishes on automobile parts since World War I; later developments considered include "double layer" buffed nickel chromium coatings, bright nickel coatings under bright chromium and chromium plating bright nickel.

New Technology — Solid State Physics, M. FERENCE, Jr. Paper No. 23B presented Jan. 1958, 35 p. Advances made by solid state science and its role in discovery of new materials; intrinsic properties of solids; transistor pointed out as classic example of manner in which basic research on fundamental behavior of electrons in solids has led to completely new and useful device; study of surface of solids; superconductivity and cryotron; magnetic resonance and masers; photoconductive, luminescent and electroluminescent materials.

Use of Ameripol SN in Tires, W. L. SEMON, M. A. REINHART. Paper No. 28A presented Mar. 1958, 10 p. Four types of Ameripol SN (Types A to D) for large scale tests; Type A, as complete replacement for rubber in tread and carcass stocks of heavy duty bus and truck tires has undergone extensive testing; results on sixteen 11.00 × 20 express tires.

Tire Cord Materials, R. P. POWERS. Paper No. 28B presented Mar. 1958, 6 p. Basic function of cord and forces and repeated stresses which it must withstand under varying temperature conditions; requirements for cord are tensile and stretch characteristics, flex resistance, stability under heat, adhesion and cost; only prominent materials meeting requirements are rayon, nylon and steel; comparison and evaluation of various tires.

Engineering Requirements of Tire Materials, E. H. WALLACE. Paper No. 28C presented Mar. 1958, 8 p. Principal forces to which tire is subjected; cord elements are disposed in envelope in various ways to obtain different tire characteristics; tubeless tires; improvements in materials and constructions; comparison of power consumption of three tires shows that natural rubber treads wear better at low ambient temperatures, but synthetics wear better at higher temperatures.

Cord Adhesives in Tires, R. H. SPELMAN. Paper No. 28D presented Mar. 1958, 10 p. Factors to consider in development and improvement of tire cord adhesives; factors influencing adhesion, degradation, and adhesive penetration and pickup; elastomer performance; need of methods for improving fatigue resistance of cord with reference to rayon, nylon, Fortisan, Dacron, and others.

Treadwear Requirements of Tires, T. A. RIEHL. Paper No. 28E presented Mar. 1958, 9 p. How improvements in ride, stability, maneuverability, and comfort of modern cars affect performance of tire; test results determining effect of car, braking and acceleration, speed and tensile retention on treadwear; means of improving treadwear by improving basic tread stock material, i.e., rubber and carbon black; protection of tread stock; basic differences in construction of conventional and belted type tire, and advantages of latter.

Some Observations on Aging of Low Carbon Sheet Steel, E. R. MORGAN. Paper No. 30A presented Mar. 1958, 10 p. Theory of yielding and aging and difficulties encountered in applying theory to control of aging in commercial steels, such as are used for automobile pressings; theory of strain aging, stages and rate of aging; it is concluded that aging is controlled by rate of migration, time available for migration and amounts of carbon and nitrogen which are free to migrate.

These digests are provided by Engineering Index, which abstracts and classifies material from SAE and 1200 other technical magazines, society transactions, government bulletins, research reports, and the like, throughout the world.

Continued from page 105

Jet Aircraft Shrinking the World

Based on talk by

JAMES J. BINGHAM
General Electric Co.

(Presented before SAE Mid-Continent Section)

IN 1910 a research airplane flew at the speed of 100 mph; by 1920 this speed was attained by a commercial aircraft. In 1959 we will fly at approximately 600 mph. And since a research airplane flew 1200 mph in 1950, we can look for this speed to be equaled or bettered by commercial airlines by 1963 to 1965.

The greatest single contributor to this great advance in speed was the turbojet engine, introduced in 1942, which can fly at higher speeds and higher altitudes than the reciprocating engine.

TWA, Delta, Capitol, and other airlines have bought the Convair 880 powered by the General Electric CJ805, the commercial version of the military J79. It is a single-spool, light-weight engine with thrust in excess of 10,000 lb. The jet transport will reach its destination twice as fast with twice the number of people as the present reciprocating-powered aircraft. It is more expensive than its DC-6 or DC-7 counterpart, but its greater utility and possible lower operating cost may improve the economics of airline travel.

3 Keys to Better Transmission Fluids

Based on talk by

NORMAN A. HUNSTAD
General Motors Corp.

(Presented at the SAE St. Louis Section)

THREE factors need improvement in automatic transmission fluid: viscosity, oxidation resistance, and durability.

The need for better low-temperature fluidity and increased high-temperature viscosity are shown by tests in the Fuels and Lubricants Department of General Motors Research Staff. Failed transmissions result when fluids are used which are inadequate in either of these properties.

Improved oxidation resistance is required, due to higher operating temperatures and increased breathing of modern transmissions. Modifying the L-39 oxidation test with air injection is under study.

Accompanying the need for better oxidation resistance is that for longer life with respect to squawk. A full-throttle dynamometer test is under development for use in evaluating this fluid characteristic.

Amendment Advances Civil Air Regulations

Based on paper by

OSCAR BAKKE
Civil Aeronautics Board

(Presented before the SAE Metropolitan Section)

TO accommodate the civil jet transport, the transport category performance limitations of the Civil Air Regulations have been amended by special regulation SR-422.

SR-422 abandons the "V-square" rule, which relates minimum rate of climb to the stall speed, and, instead, prescribes absolute values of climb gradient, which have been determined principally on the basis of CAB's experience during the past 10 years. It provides for temperature accountabil-

Continued on page 124

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...farm equipment
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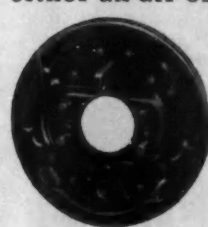
"DM" DUPLEX MECHANICAL BRAKE

Best on many jobs. It has proved its worth with farm equipment, special duty utility trailers, light duty highway trailers, industrial machinery, and in a wide variety of special applications.

Greater torque output! The DM Brake is a self-energizing, balanced type . . . the two identical shoes do an equal amount of work in either forward or reverse direction.

Simpler Maintenance and Adjustment! The DM Brake is wedge-actuated through an easily accessible operating lever, giving positive braking with immediate response. It can be actuated by either an air or hydraulic cylinder, or mechanical means. Complete accessibility for quick, easy adjustment. Simple design keeps maintenance and service at a minimum.



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For every industrial, agricultural or automotive application where braking is required!

Continued from page 122

ity in all stages of flight except the landing distance, and includes humidity accountability related to the temperatures involved. It rationalizes the airplane performance in the take-off and en route stages of flight by relating it more closely to the existing operating conditions and to the particular features of the airplane.

To the utmost extent possible, SR-422 reflects full appreciation of the many operational factors which directly affect performance, such as pilot technique, normal deterioration of engine power, variability of drag characteristics, change in aerodynamic qualities, operational difficulties in maintaining precise control of basic aircraft weight and balance, instrument errors, and errors in the measuring of meteorological variables such as winds and temperatures.

Unquestionably the regulation is based on rather involved technical considerations, but they are substantially verified by past experience. It is obvious, too, that compliance with these requirements demands a more judicious application by aircraft operators than has been the case heretofore. The characteristics of the airplane make it unavoidable and the growing interest of the public and its principal political and technical spokesmen will permit nothing less.

To Order Paper No. S63 . . .
on which this article is based, see p. 5.

What Diesel Users Can and Cannot Have

Based on paper by

J. F. GREATHOUSE
Mack Trucks, Inc.

(Presented at SAE Metropolitan Section)

USERS of automotive diesel engines can think up many improvements they'd like to see incorporated in current design. Here are some of them with comments on what can be expected:

1. Lower first cost: Everybody wants to see this, but extensive simplification is the road to cost reduction and this is incompatible with the desire for other improvements.

2. No maintenance or service: The day of the sealed-for-life, high-performance diesel is beyond the horizon, but there are real opportunities to lower service costs. The greatest gains may come through improvements in lubrication.

3. Simplicity of operation and positive control: Great strides have been taken to make operation automatic and improvements will continue.

4. No smoke; no odor: Some manufacturers and users operate at 100% rack and over to get the maximum from their engines. This is uneconomical and smelly. There is scant hope for improvement while operators and anxious-to-please designers look to residual fuels for lower cost and more power.

5. Easy starting: With good starting motors and low ignition point fluids, properly used, there is no great problem at temperatures above 10 F. More drastic starting aids are necessary for subzero temperatures. The best aid to initiating combustion is fast cranking. An oil to provide easy cranking at – 65 F and still do its duty at 300 F would be the answer. A special fuel improver to permit low-temperature ignition for cold starting without changing ignition lag at normal operating temperatures would be a help.

6. Insensitivity to lubricants. As engine power performance is increased, the sensitivity to lubricant quality will increase rather than decrease.

7. Insensitivity to fuel variation: Opportunists are looking greedily at the residual fuels, but unfortunately even the lighter residuals are unfriendly to the general run of smaller high-speed diesels. Engine deposit troubles increase with their use, so that users must balance fuel economy against more frequent maintenance.

8. Lighter weight. The trend in specific weight is downward.

To Order Paper No. S59 . . .
on which this article is based, see p. 5.

Continued on page 127

Here's a NEW WELDING TORCH that's WATERTIGHT... built for HEAVY-DUTY SERVICE ...yet weighs only 7 OUNCES!

This new HELIARC HW-18 Hand Welding Torch weighs only 7 ounces, making it easy for you to handle, less tiring. The special one-piece water cooling channel eliminates sources of leakage. And it's made for rugged, heavy-duty service.

YOU GET BETTER SHIELDING WITH LESS GAS

Improved design of collet body and closer electrode fit assure uniform argon flow, without jetting or turbulence.

◀ Diagram shows leakproof, one-piece water cooling passage in LINDE's new HELIARC HW-18 Hand Welding Torch.

GIVES YOU RUGGED SERVICE

Torch body is Fiberglas-reinforced phenolic for greater resistance to heat and thermal shock. Handle is tough, polished plastic. Gas cups have 4 times the impact strength of ordinary cups.

LEAKPROOF

Molded, one-piece water cooling passage has no joints to permit leakage—no water drip to contaminate welds.

EASY, MORE ECONOMICAL MAINTENANCE

Collets, collet bodies, cups and caps are interchangeable with those of your HW-17 Series 2 Torch. All couplings have standard IAA connections, and adaptors are included. Your production costs are lowered, too, for the new HW-18 saves time in hard-to-reach spots. Torch is designed for continuous 300-amp service, a-c or d-c.

ARGON SHUT-OFF VALVE

(Optional) saves time, steps and argon.

See and try this new HELIARC HW-18 Torch! For a demonstration, mail coupon today. Or call your distributor or nearest LINDE office. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Dept. SA-6, LINDE COMPANY, Division of UCC
30 East 42nd Street, New York 17, N. Y.

Please advise me where and when I can examine and try out the new HELIARC HW-18 Hand Welding Torch.

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CITY ____________ ZONE ______ STATE ______

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The terms "Linde," "Heliarc," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Continued from page 124

Cost Control Saving Navy Millions

Based on talk by

COM. N. L. MARTINSON
Potomac River Naval Command
U. S. Naval Gun Factory

(Presented before SAE New England Section)

THE Navy is now spending \$16½ million less annually than it did three years ago to keep its land transportation running. This is accredited to its transportation management program.

Cost control, part of the program, which began with automotive equipment and was later expanded to cover all types of equipment, has resulted in the use of 2800 fewer people in its shops.

Throughout the Navy there are 83,000 items of automotive, weight handling, construction, and railroad equipment in operation, representing a replacement cost of over \$600,000,000, which have to be maintained in condition. The transportation management program was put into effect to safeguard this investment, particularly because no increase in funds for maintenance could be expected, the purchasing power of the maintenance dollar was shrinking, and new facilities were being added at the rate of \$400,000,000 annually.

Air Force Lowers Major Accident Rate

Based on talk by

COL. J. C. BAILEY
Flight Safety Research
Office of the Inspector General, USAF

(Paper presented at joint meeting of SAE Texas Section and IAS Texas Section)

AS AIRCRAFT gain in performance and speed, a single accident is apt to be more disastrous than it was in the past.

From 1922 to 1950 the flying hours increased from 198 to 2741 per major accident—a worth-while gain for a 28-year period. From 1950 to 1956 the flying hours per major accident rose from 2741 to 6716 to establish the most dramatic gain in any 6-year period. In 1950 the Air Force flew 16,152 hr per pilot fatality, today it flies over 27,000 hr per pilot fatality, and few pilots accumulate so many hours during their careers. Exposure to the possibility of accidents is high, but actual accidents are low in relation to the high potential. Still, the Air Force

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will be unsatisfied until the irreducible minimum is reached, whatever that minimum may be.

Jet fighter and trainer aircraft have the highest accident rate. They flew only 10% of Air Force flying time in 1950, yet they accounted for 31% of major accidents, 35% of all aircraft destroyed, and 31% of pilot fatalities. Today they fly 31% of Air Force flying time but have 69% of the major accidents, 75% of the aircraft destroyed, and account for 63% of all pilot fatalities. Despite the increase in proportion of total accident losses, the major accident rate of these aircraft has declined by 71% between 1950 and 1956. Jet bombers, which fly less than 10% of all flying time, have less than 5% of major accidents and 5% of aircraft destroyed, but they account for 25% of the dollar value of aircraft lost in accidents.

Where Jet Accidents Happen

Jet major accidents take place as follows: landing phase 45%, in flight 32%, take-off 16%, go-around 3%, taxiing 2%, and miscellaneous 3%.

Pilot error, the largest single cause of accidents, declined to 48% in 1955 and 45% in 1956. This represents a consistent trend since 1952. On the other hand, material failure trended downward as a cause of accident until 1954, then increased from 24% in 1955 to 26% in 1956.

Early in 1955 the Directorate of Flight Safety Research shifted emphasis from field accident investigation to accident prevention of another type. It has been trying to ferret out accident cause factors on the drawing board, on the production line, in the training schools and maintenance shops, and in flight. While field investigation is continued, the effort is now made to get ahead of accidents by preventing them before they have an opportunity to occur.

How to Get Low-Cost Truck Operation

Based on talk by

E. C. PAIGE

Ethyl Corp.

(Presented before SAE Southern California Section)

TRUCK engines must be designed to make the best use of the antiknock quality of available gasolines, and each engine must be properly adjusted for the specific gasoline used, in order to achieve the lowest-cost truck operation.

The gasolines available to truck operators vary considerably in antiknock quality, and engine designers have to take this into account. Accordingly, they must select the engine compression ratio and distributor spark-advance characteristics which will give optimum performance and fuel economy with the various available fuels.

As examples let us take two distributor spark-timing curves for a high-compression engine. One was designed for a gasoline of relatively low octane number and the other for a gasoline of average octane number. When the "low-octane" distributor curve was used, adjustment of basic spark timing for higher octane gasolines gave poorer performance than was achieved with the "average-octane" curve. On the other hand, engine performance suffered when the "average-octane" curve was adjusted for low-octane gasolines. Thus the optimum spark-advance curve would be a compromise between the two curves cited.

The commercial success of a truck, however, lies largely in the hands of the maintenance group. In addition to maintaining cooling systems and carburetors, maintenance functions include determining the basic spark setting required and, among other things, checking for worn distributor drive trains, which will cause erratic spark timing in the various cylinders.

. . . performance beyond the usual . . .

Design of high-speed precision machinery often calls for bearings which offer the utmost in load capacity, "hot hardness", dimensional stability. Each machine presents its own exacting requirements.

Fulfillment of unusual requirement combinations is a specialty at Rollway. Your selection of exactly the right precision radial cylindrical roller bearing is assured by:

- **A broad range of types and sizes, numbered in the thousands**
- **Retainers of standard bronze or "Rollube" ferrous alloy, in roller-riding, land-riding, or broached construction**
- **Crowned rollers**
- **Modification of any factor to meet your application**

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ROLLWAY
Maximum
ROLLER BEARINGS

New Members Qualified

These applicants qualified for admission to the Society between April 10, 1958 and May 10, 1958. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

R. Jack Alexander, Jr. (A).

Baltimore Section

Mason Joseph Reilly (M), R. M. Weitzel (A).

British Columbia Section

Aidan Blundell (A), Joseph Edward Robinson (A), John Moore Graham Ross (M).

Buffalo Section

Jerold James Gilmore (J).

Canadian Section

William Blake Dodds (A), John Edwin McCormack (M), C. R. McMillen (M), John F. Quatsch (A).

Central Illinois Section

Charles E. Adams (J), Bernardo Rual Heker (J), Dorwin Ray Larsen (J), Howard Arthur Marsden (J), William R. Metzke (M), Michael K. Stratton (J), Roger Erwin Treick (J).

Chicago Section

Sumner L. Barton (M), Jonathan Freeman Bushnell (M), Marvin E. Holmgren (J), Raymond H. Mattsen (A), Fred E. Newmarker (A), Heinz Von Kroog (A).

Cincinnati Section

Richard J. Smith (M).

Cleveland Section

Richard C. Bryan (M), Wallace L. Dennis (A), Jeremy W. Gorman (M), Robert A. Hein (J), Bartholomew J. Kitko (J), Paul John Kolarik (J), William G. Lesso (J), James E. McClintock, Jr. (A), Eugene E. McMannis (M), Guy Douglas Payne, Jr. (M), J. A. Smith (M), Harold M. Straub (M).

Dayton Section

Gerald L. Furrey (A).

Detroit Section

Alan P. Anderson (J), Richard V. Anderson (M), Donald Bach (M), Alfred E. Bannister (J), Roland A. Brandau (M), Donald E. Cardoze (J), Eugene A. Carpentier (M), Wilbur H. Clevenger (M), George S. Cowing (M), Raymond A. Dittmer (M), Robert D. Dushaw (J), A. F. Duttweiler, Jr. (M), Marvin E. Fawley (M), Roger T. Goulet (M), Max L. Hoolihan (M), F. R. Householder (M), Peter Ilitch (M), Kent B. Kelly (J), Donald R.

Continued on page 132

New Members Qualified —

Continued

King (M), Albert H. Leese (A), Eugene Malanyn (M), Kenneth McBroom (M), Duane Francis Miller (J), Herman R. Nichols (A), Josue R. Picon (M), Hugh Edwin Pritchard (M), James Gilbert Roddewig (M), Willis L. Schulz (M), John Micheal Seaton (J), Robert L. Thrun (M), Edward P. Tighe (A), Marius A. van Merkensteijn (A), James W. Wells (A), Frederick Wolf Zappert (M), David P. Zart (A), Frank W. Zawodni (J), Alex Zisis (J).

Hawaii Section

Thomas M. Ishimoto (A).

Indiana Section

Edward T. Mabley (M), Robert E. McAfee (M).

Kansas City Section

William Charles Haas, Jr. (M), 1st Lt. Nick J. Itsines (J).

Metropolitan Section

Barrett A. Bailey (J), Thomas John Campbell (J), Harold MacKay Cashmore (A), John DiPippa (A), Ronald Doran Eber (A), Edward R. Eckert (M), Bruce J. Gordon (M), John M. Jarboe, Jr. (A), Raymond C. Kopituk (M), Herbert James Lindenbaum (M), Einer Erik Sven Malmberg (M), Henry H. Michaels, Jr. (A), William J. Scavuzzo (M).

Mid-Michigan Section

Robert J. Carter (M), William C. Cole (M), Richard J. Roberts (J).

Milwaukee Section

Theodore J. Holtermann (J), Werner E. Isola (M), Robert A. Olen (M), Edward J. Retzinger (A), Walter E. Rheault (M).

Mohawk-Hudson Section

Richard G. Austen (A), William A. Cross (A).

Montreal Section

Arthur Cliffe-Agnew (A), Arch G. Currie (A), Maurice J. Friesen (A), John Alfred Reader (M), Eric Albert Spicer (A).

Northern California Section

John W. Freund (A), Per K. Reichborn (J).

Northwest Section

Richard Beresford (M), George J. Graham (A), Harry A. Hescox (A), Robert Lee Larrabee (A), Amir M. Mirsepasy (M), Nels H. Smedberg (M).

Oregon Section

Clarence P. Baker (A), Robert Eastman Cox (A), Hary A. Van Cleve (A).

Philadelphia Section

William E. McCafferty (A), Paul A. Murphy (M), Edward Roy Taylor, Jr. (M).

Pittsburgh Section

George A. Roberts (M).

St. Louis Section

Oliver B. Cruse (M), Robert B. Oetting (J), Kenneth T. Walden (M).

Salt Lake Group

Donald J. Balka (A).

San Diego Section

Rollin K. Norris (A), John E. Stoddard (M), Charles M. Volker (M), Ben Gee-Bun Wong (M).

South Texas Group

Thomas H. Barton (A).

Southern California Section

John M. Cazier (M), Ronald L. Dempsey (J), Sal J. Grassadonia (M),

Continued on page 134

New Members Qualified —

. . . . continued

Eugene R. Grieshaber (M), Clarence Roy Herring (M), Sidney Laham (J), Wolfgang S. Lang (M), J. A. Lockheed (M), Howard W. MacFarland (M), Bernard L. Messinger (M), Valdemar Schmidt (M), William Schoellkopf, Jr. (A), Fred E. Schultz (J), Clyde R. Seitz (M), Gail P. Smith (A), Theodore Louis Tomaszewski (M), Marvin S. Roth (A), George H. Wheeler (J).

Southern New England Section

Charles Martin Dean (M), Howard B. Marx (M), H. Perry Smith (M).

Spokane-Intermountain Section

Lloyd G. Massender (M), Darwin Jack Riegel (J).

Syracuse Section

Clare Louis Frisbie (A).

Texas Section

Nick A. Birbilis (J), John E. Brune (J), James Martin McDonald, Jr. (A).

Texas Gulf Coast Section

Otis W. Boteler (M), Emile S. P. Farha (A).

Twin City Section

Gustav A. Larson (M).

Washington Section

Raymond J. Pflum (M).

Western Michigan Section

John O. Lundwall (A), John T. Mehne (M).

Wichita Section

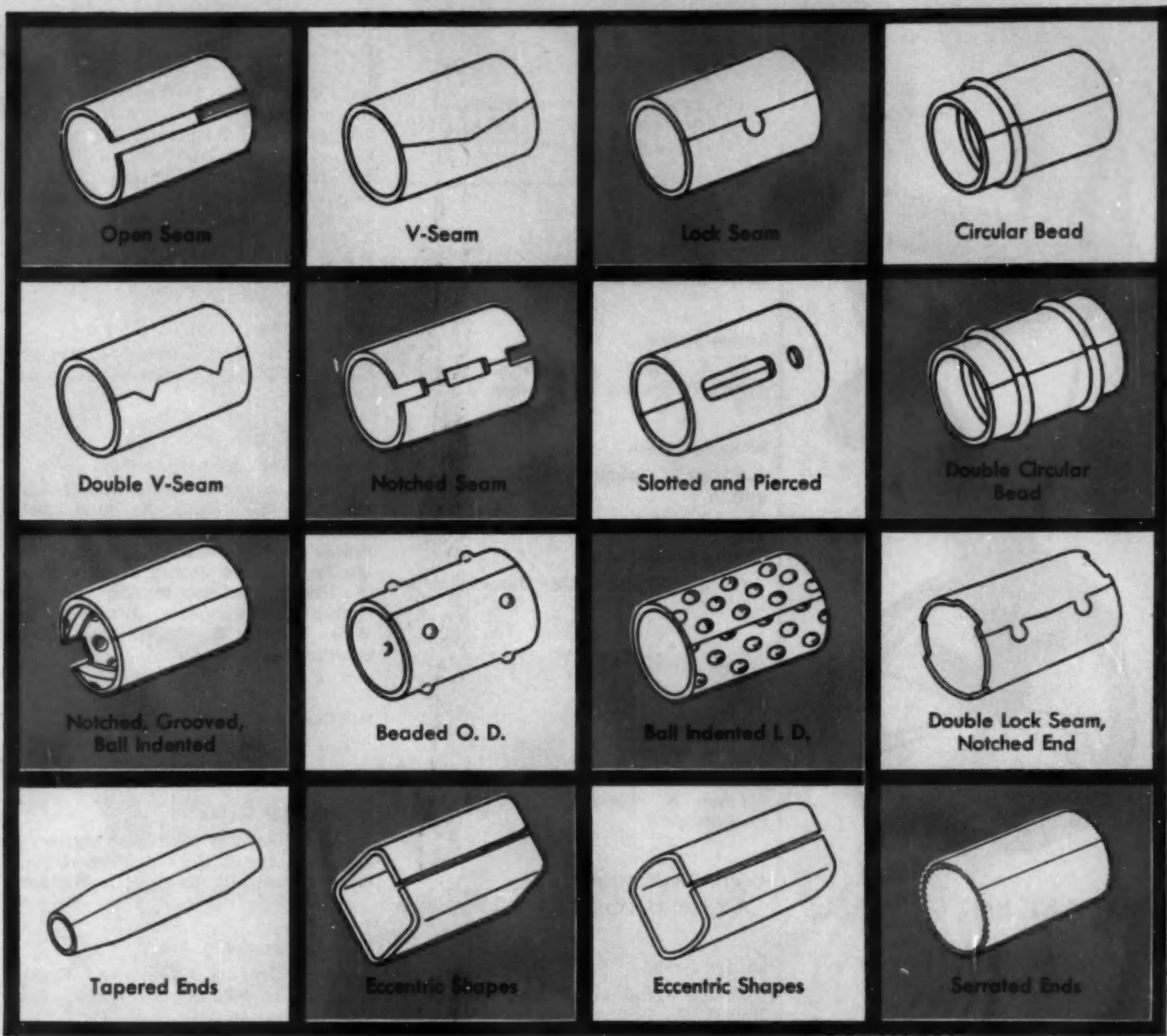
Kenneth Delaplaine (M), Fred Ricketts (A).

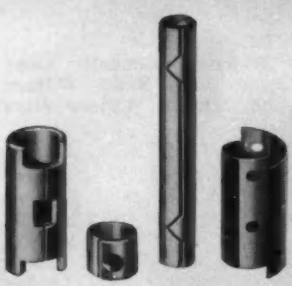
Outside Section Territory

William L. Becker (M), Ralph S. Bennett (A), Edward F. Fricker, Jr. (A), Donald I. Malm (M), C. W. Mortensen (M), Michael J. Phillips (M), Thomas Alfred Tennyson (M), John H. Willard (A).

Foreign

Bernardino I. E. Dasso (A), Argentina; Julius Kong (M), Brazil; James Harvey Nelson (M), England; Pablo J. Palomar (M), Spain; Sylvio de Aguiar Pupo (M), Brazil; Ronald George Richardson (M), East Africa; Louis A. Sellier (M), Venezuela; Walter Thomas Warner (M), Australia.





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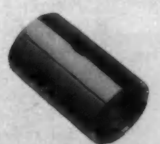
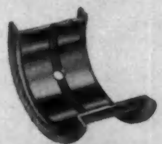
Copper-Alloy Lined


Plain & Bimetal Split Bushings


Bearing-Surfaced Thrust Washers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Applications Received

The applications for membership received between April 10, 1958 and May 10, 1958 are listed below.

Alberta Group

Dennistoun Johnstone, Gavin Mann, Lloyd Douglas Thompson

Atlanta Section

L. J. Galati, Edward P. Leibold, James P. Trebes, Roy James West

Baltimore Section

Irving L. Goldstein, Charles E. Marquette

British Columbia Section

Gordon Ernest Batley, James Samuel Curtis

Buffalo Section

Samuel Egnot

Canadian Section

Winston C. A. Hay, James R. Knox, Mayne R. Plowman, Edwin John Stefanczyk

Central Illinois Section

William G. Dixon, Edward R. Joseph

Chicago Section

James V. Calvano, Luis Chong-Leon, Daniel E. Gaffney, William Marosy, John L. Mickle, Jr., Robert A. Moss, Fred J. Schmitt, John C. Souders, Alva J. Ward, Herbert A. Winkelmann

Cincinnati Section

Lucius A. Sullivan, Donald E. Uehling

Cleveland Section

Robert L. Bound, John H. Bromelmeier, Sampel M. Darling, Robert R. Davidson, Robert G. Dunlop, Russell H. Edwards, Peter Albert Hassell, Edgar W. Hylbert, Jr., Carl L. Kahlert, Edward William Kochevar, Donald W. Liechty, Joseph Thomas Lundy, George R. Norman, James A. Young

Dayton Section

Austin D. Bishop, John Franklyn Hedge, Charles C. McLean

Detroit Section

Raymond G. Antos, John J. Bohmrich, William S. Carleton, Robert A. Carrier, Harry N. Copp, Ernest E. Fehlman, Paul A. Gates, Norbert J. Haase, Ernest B. Harper, Jr., Wilbur T. Hooven, III, Lawrence F. Jenkins, John R. Kearfott, Richard H. Lovdahl, Richard G. Mosher, Charles D. Parker, E. Tilson Peabody, Ronald J. Querciagrossa, E. Paul Remmers, Carl C. Runyon, John P. Sanders, William E. Schulz, Tanas M. Sihon, John B. Smyly, William A. Sulak, William B. Thomason, Ernest M. Werner, Robert A. Wilkins, Russell J. Woodruff, Conrad D. Woods, Gerald P. Wright

Indiana Section

Donald L. Boyes, John Martin McClellen, William Charles Stoltenberg

Metropolitan Section

Edmundo Badler, Edward Bruce Belason, Joseph H. Hartzenbusch, C. J. Heine, L. S. Hollins, E. Paul Kovac, Nicholas Kulba, Robert J. Lasky, Dr. Friedrich W. Lohmann, Benjamin F. Moore, Michael James Perillo, Frank G. Preyer, Robert Martin Reithner, Richard P. Schroeder, James A. Van Wyk, Marvin W. Wainwright, Dieter George Eugen Wolff

Mid-Continent Section

Erwin T. Kaltwasser

Mid-Michigan Section

John Gordon Butler, Myron A. Frank, Harry R. Schaal, Herbert Frederick Thrun, Jr., Ronald O. Warner

Milwaukee Section

John Gregory Hessburg, Gordon Dean Kelly, William C. Oswald, Ernst Carl Sauerman

Montreal Section

R. A. Esmonde, Kenneth Lloyd Griffith, Peter John Neild, William Geoffrey John Thorne, Andrew Allan Tolhurst

New England Section

Charles G. Cameron, William E. Dowdell, Wallis N. Fisher, Edward Joseph Goldman, Samuel Lack, Lloyd Hampton McFadden, Jr., George Schultz, Raymond M. Sears

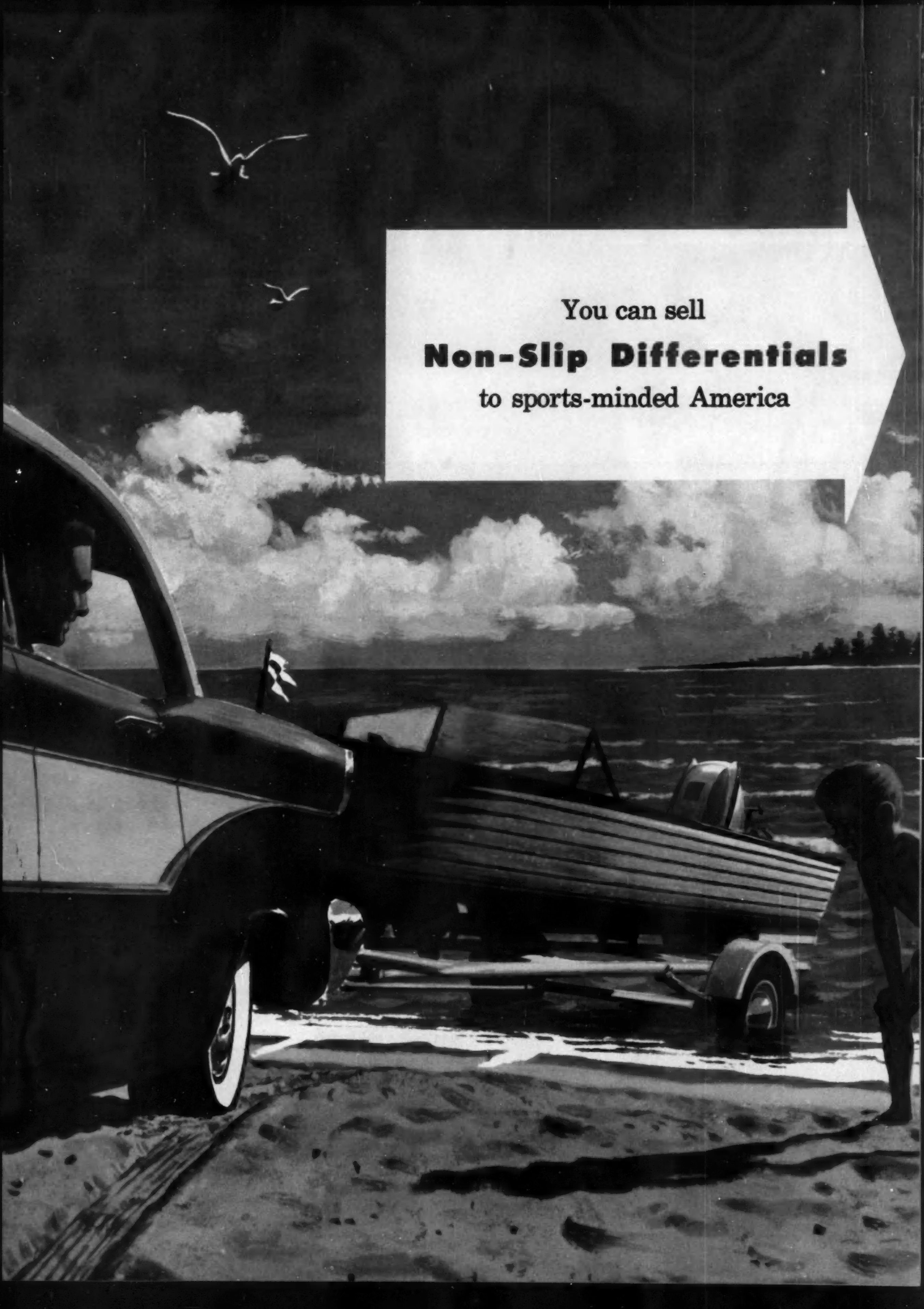
Northern California Section

Joseph A. Belaire, Armor W. Harris, E. Clair Hill, Gerald R. Holly, Thomas Allan Hunter, John L. Moyer, Roy Swanson

Northwest Section

Arthur Edward Eckert, L. J. "Bud" Gilroy, Lawton F. Morris, Gilbert Wittlin

Continued on page 139


You can sell
Non-Slip Differentials
to sports-minded America

Applications Received

Continued

Oregon Section

Dan K. DeSart

Philadelphia Section

Michael P. Bereschak, Robert Ebenbach, Harry T. Neher, Fernando Albert Pellicciotti, Charles F. Walsh

Pittsburgh Section

Alvin G. Cook

St. Louis Section

John C. Ryan

San Diego Section

David S. Hackley

Southern California Section

A. William Brown, Gale C. Corson, Demosthenes Paul Dakos, Fredric H. Graff, Hugh E. Hale, R. A. LeMaitre, Duncan Albert Puett, Arnold Walter Siegel, Hugh Morgan Stilley

Southern New England Section

Herbert Woodruff Bainton, Thomas P. Nagle

Spokane-Intermountain Section

Kenneth S. Mather, Hubert F. Randall

Texas Section

James R. Moran

Twin City Section

Charles Milnar, Theodore H. Olson

Virginia Section

Clifton H. Cook

Western Michigan Section

Clarence N. Bouman

Williamsport Group

Kenneth L. Felker

Outside Section Territory

Loy Martin Clemmer, Jerry Henzl, Raymond R. Perine, Jr., Albert Neal Perry, Ernest Edwin Robertson, William L. Rumgay, W. W. Williams

Foreign

Frederick Arthur Mean, Bermuda; Sr. Don Antonio Mora, Spain; Dr. Mahmoud Hassaan Saadawi, Egypt; Joseph Jeyaratnam Subramaniam, Ceylon; Prof. Ir. H. C. A. van Eldik Thieme, Holland; Tadamasa Yoshiki, Japan

C/R now offers you the advantages of reinforced TFE... designed, compounded and molded by a single source!

If your work involves sealing applications, you are probably familiar with "Teflon", Tetrafluoroethylene Resin. The extreme versatility of its chemical, thermal and mechanical properties are unmatched by any other material on the market.

You may not be, however, fully aware of the degree to which these properties can be distinctly improved by the use of reinforcing inorganic additives. For example, "Teflon" can be blended with inorganics to increase:

- **Resistance to deformation under load — by a factor of 10**
- **Resistance to wear by rotating shafts—by as much as 500 times**
- **Stiffness — by a factor of 4-5**
- **Thermal conductivity—by a factor of 5-10**
- **Compressive strength — by a factor of 3-4**
- **Hardness — by 10%**

It is also useful to know that Chicago Rawhide is one of the few fabricators which blends its own "Teflon" compounds, assuring constant quality in batch after batch and permitting compound formulations to be developed rapidly and accurately. Our new laboratory and production facilities are unexcelled – and these facilities are matched by our experience in molding synthetic parts to meet the most critical specifications.

C/R Sirvene welcomes the opportunity to cooperate with you in the design and production of "Teflon" and reinforced "Teflon" packings, bearings, gaskets, rings, or other parts.

If you are interested in "Teflon" write for your free copy of Sirvene Materials Bulletin CT-1.

***"Teflon" is a DuPont registered trademark**

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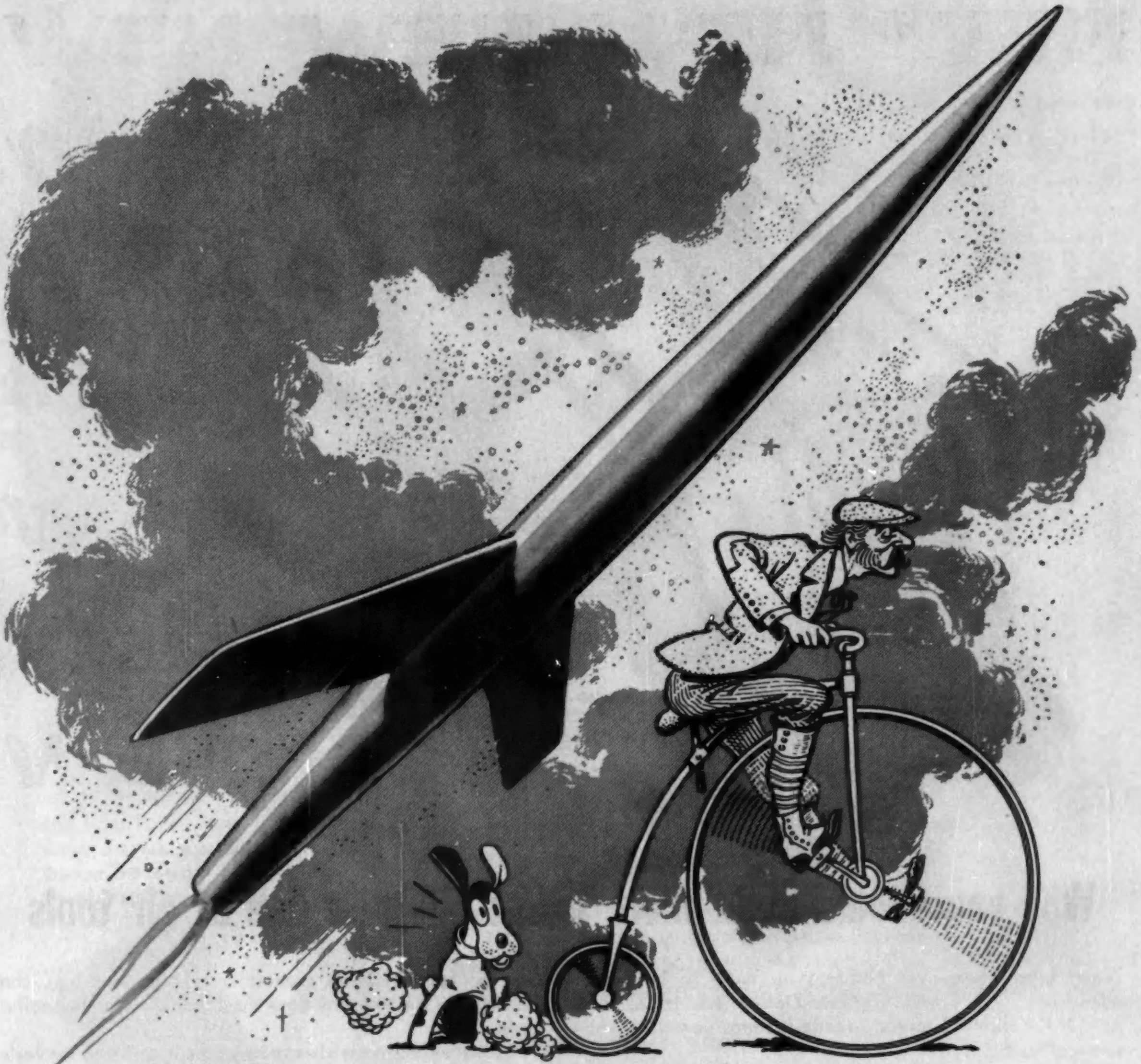
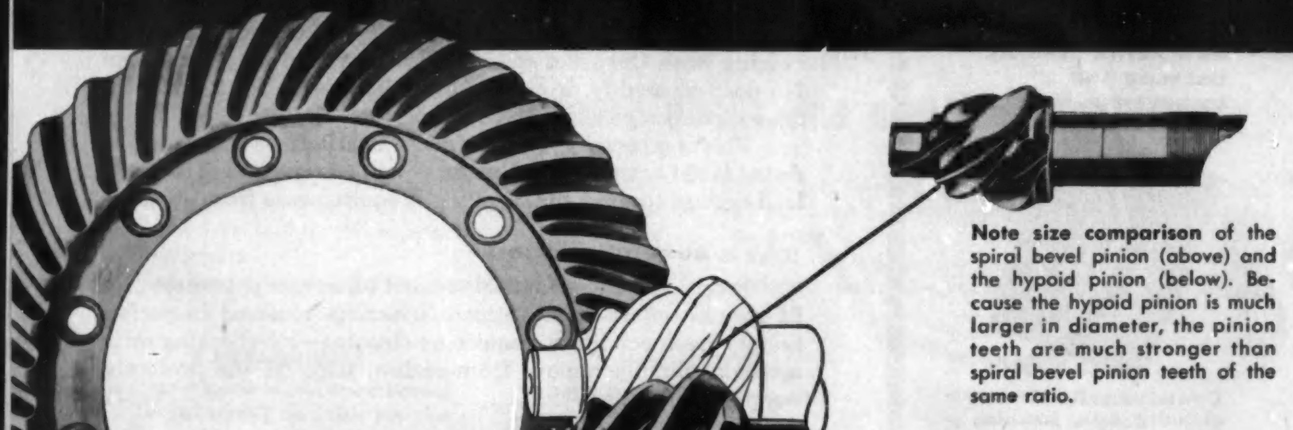
Offices in 55 principal cities. See your telephone book.
In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario. **Export Sales:** Geon International Corp., Great Neck, New York.
Other C/R Products: *C/R Shaft and End Face Seals • Sirvis-Conpar mechanical leather cups, packings, boots • C/R Non-metallic Gears*

SIRVENE C/R DIVISION
CHICAGO RAWHIDE



Hypoid Gears 30% More Torque Than Spiral Bevels!



Note size comparison of the spiral bevel pinion (above) and the hypoid pinion (below). Because the hypoid pinion is much larger in diameter, the pinion teeth are much stronger than spiral bevel pinion teeth of the same ratio.

Hypoid Gear and Pinion. Note the hypoid pinion is offset from the center line of the ring gear. With spiral bevels the pinion is located on the center line of the gear.

Have Capacity

Timken-Detroit pioneered and developed hypoid gears for trucks of every type and capacity . . . and today is the acknowledged leader in the field!

A FEW OF THE MANY LEADERS WHO USE TIMKEN-DETROIT AXLES WITH HYPOID GEARS

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The trend of the trucking industry today is to hypoid gears, because their torque capacity is 30% greater than that of spiral bevel sets of the same ring gear diameter and ratio! The result is lower maintenance costs, greater dependability, and lower-cost operation. And, since hypoid gears do every driving axle job better . . . from the smallest single reduction axles to the largest double reductions . . . more and more operators specify them every day.

Hypoid gearing is another plus feature found in all Timken-Detroit Letter Series Single and Tandem Driving Axles!

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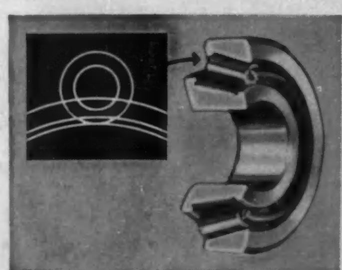


HIGHER FLANGE IMPROVES ROLLER ALIGNMENT

As shown by the gray area above, the higher flange provides a large two-zone contact area for the roller heads. This greatly reduces wear—practically eliminates "end play". Larger oil groove provides positive lubrication.

No one knows the importance of proper timing better than a farmer. Equipment has to be ready *when it's needed!* One breakdown—like a bearing failure—and everybody loses. Lost crop . . . lost money . . . and, for the equipment manufacturer, a lost customer.

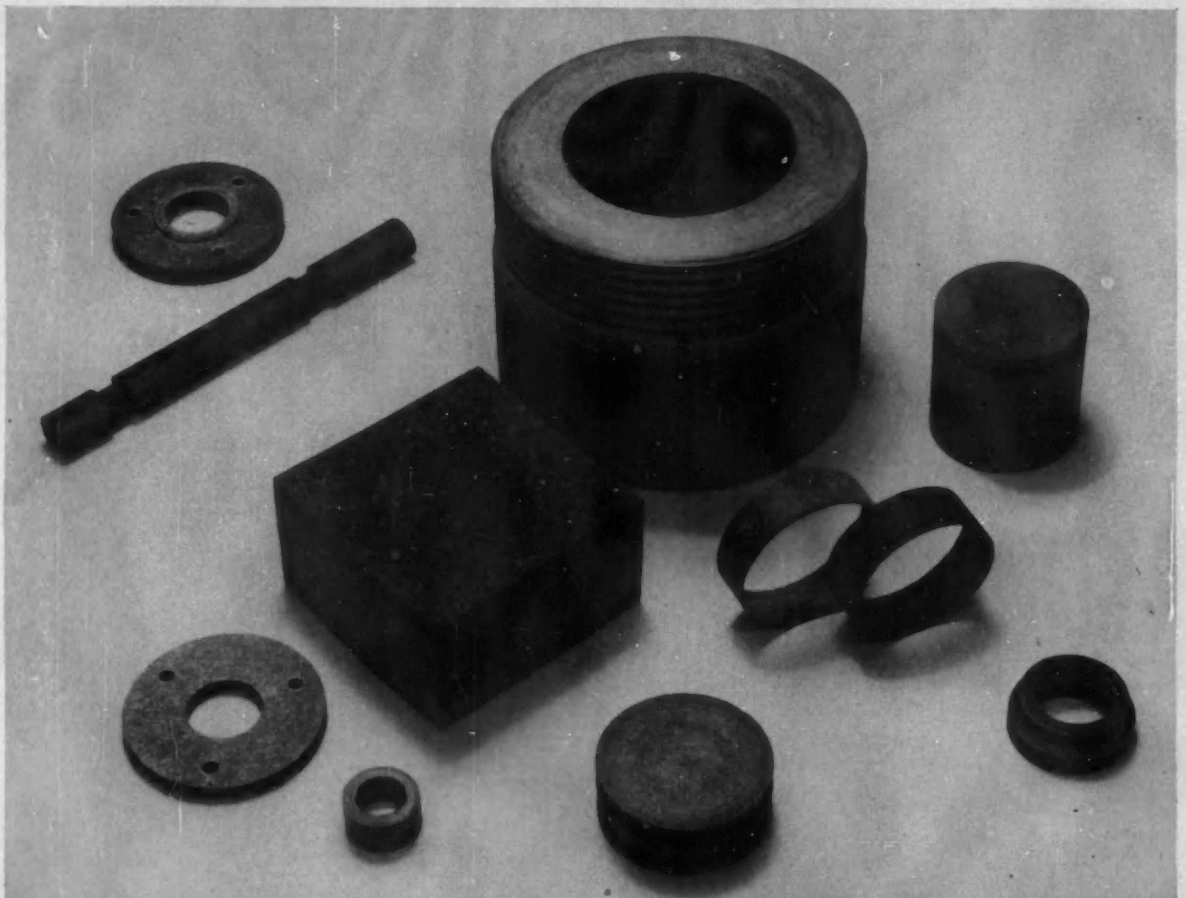
That's why so many farm equipment manufacturers insist on dependable Bower Roller Bearings. Basic design improvements like those shown at left have made bearing failure a rarity. In addition, Bower's use of quality material plus close attention to engineering detail has virtually eliminated all maintenance requirements—makes these rugged bearings last longer, perform better.

Whatever *your* product, specify dependable Bower Roller Bearings. Choose from a complete line of tapered, straight and journal roller bearings for every field of transportation and industry.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 14, MICHIGAN

BOWER ROLLER BEARINGS

R/M PYROTEX REINFORCED PLASTIC PARTS RESIST HEAT TO 10,000°F



A few of many R/M Pyrotex parts are shown here. Pyrotex, a reinforced plastic, is molded, laminated or machined into precision parts for a wide variety of applications.

R/M Pyrotex parts may be the answer to your problem for low-cost structural parts capable of resisting temperatures as extreme as 10,000°F, while still meeting structural strength and thermal insulation requirements. Pyrotex has been proven outstandingly successful in industrial, automotive, aircraft, rocket and missile applications.

Some of the advantages of R/M Pyrotex parts: have high strength-to-weight ratios and good dimensional stability; take a smooth finish; can be mass produced to precision standards; are ideally suited for bushing, bearing, sealing, braking, and hundreds of other applications—all usually at substantial savings in production costs. Write today for complete data on R/M Pyrotex parts.

THE COMPLETE LINE OF R/M REINFORCED PLASTICS

If your design demands all of the following features, find out more about R/M Pyrotex parts

- Heat and flame resistance up to 10,000°F or more
- Chemical and water resistance
- Relatively isotropic
- High modulus of elasticity from low to high temperatures (6×10^6 psi)
- High strength from low to high temperatures (60,000 psi)
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- Little or no surface crazing
- Good insulation and thermal properties
- Low cost
- High strength-to-weight ratio

For further information, write for technical bulletin

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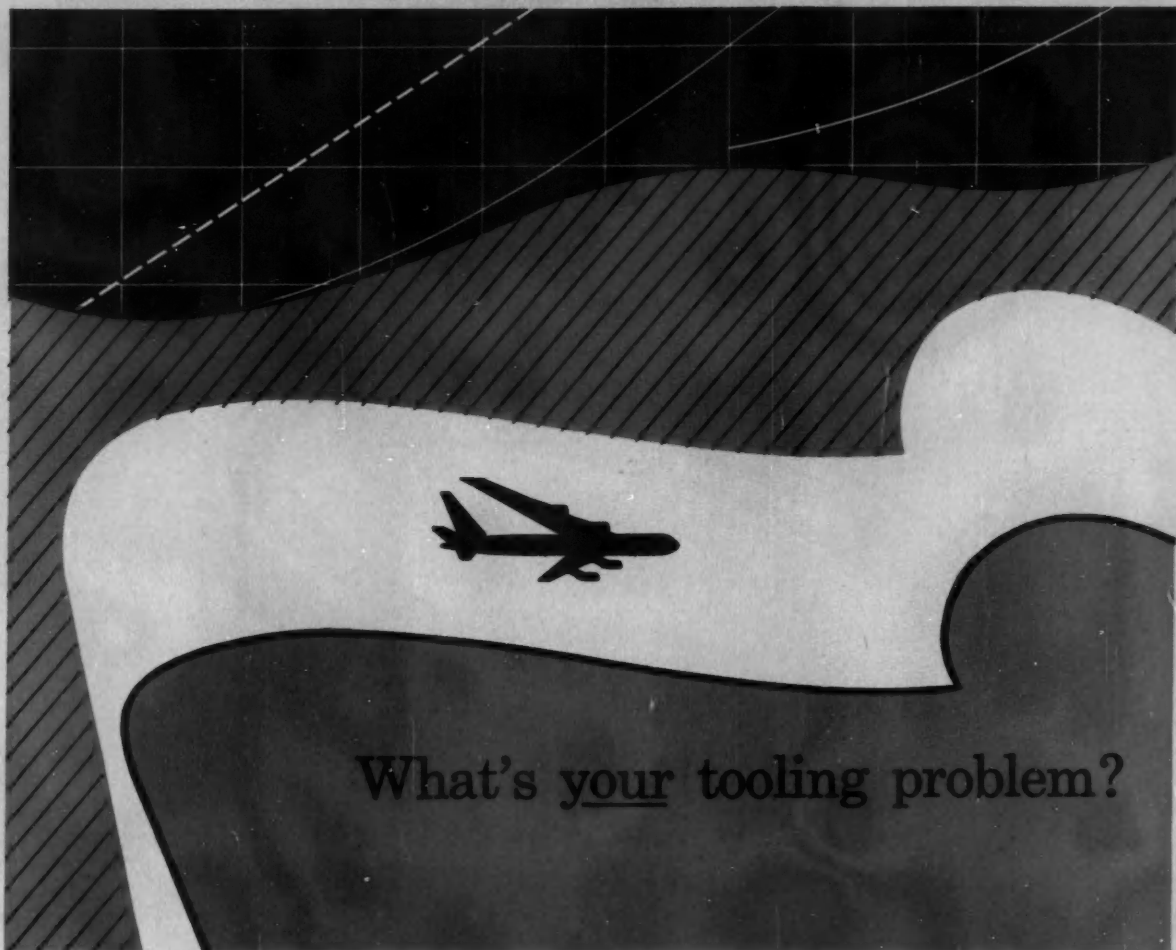
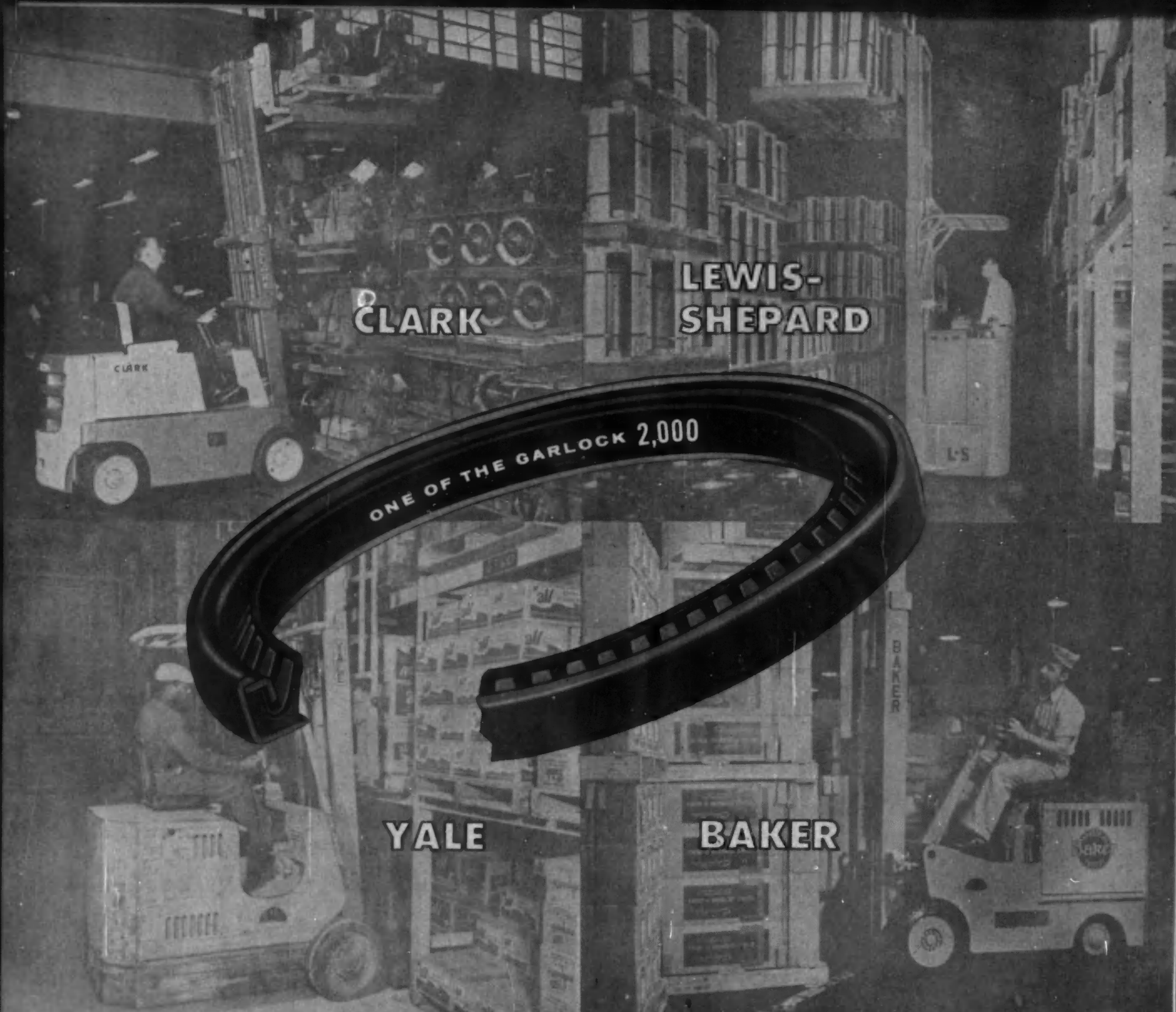

What's your tooling problem?



Why Leading Lift Truck Makers Specify Garlock KLOZURE* Oil Seals

The standard sealing element in a Garlock KLOZURE Oil Seal is a unique synthetic material molded to very accurate dimensions. It is non-abrasive, free-running; oil, grease, heat, and cold resistant; impervious to water, mild acids, and alkalies. It is also extremely durable and resilient.

That's why 20 leading Lift Truck manufacturers use KLOZURE Oil Seals for sealing-in bearing lubricants, and for protecting bearings from the abrasive action of dust and dirt.

For unusual service requirements KLOZURE Oil Seals are supplied with sealing elements made of silicone rubber for temperature extremes; or Teflon to resist strong acids, and other chemicals.

If you have a sealing problem, why not ask your Garlock representative for his recommendations from "The Garlock 2,000" . . . two thousand different styles of packing, gaskets, and seals for every need. It's the only complete line. Call Garlock today, or write for KLOZURE Oil Seal Catalog No. 20.

**Registered Trade Mark*

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For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

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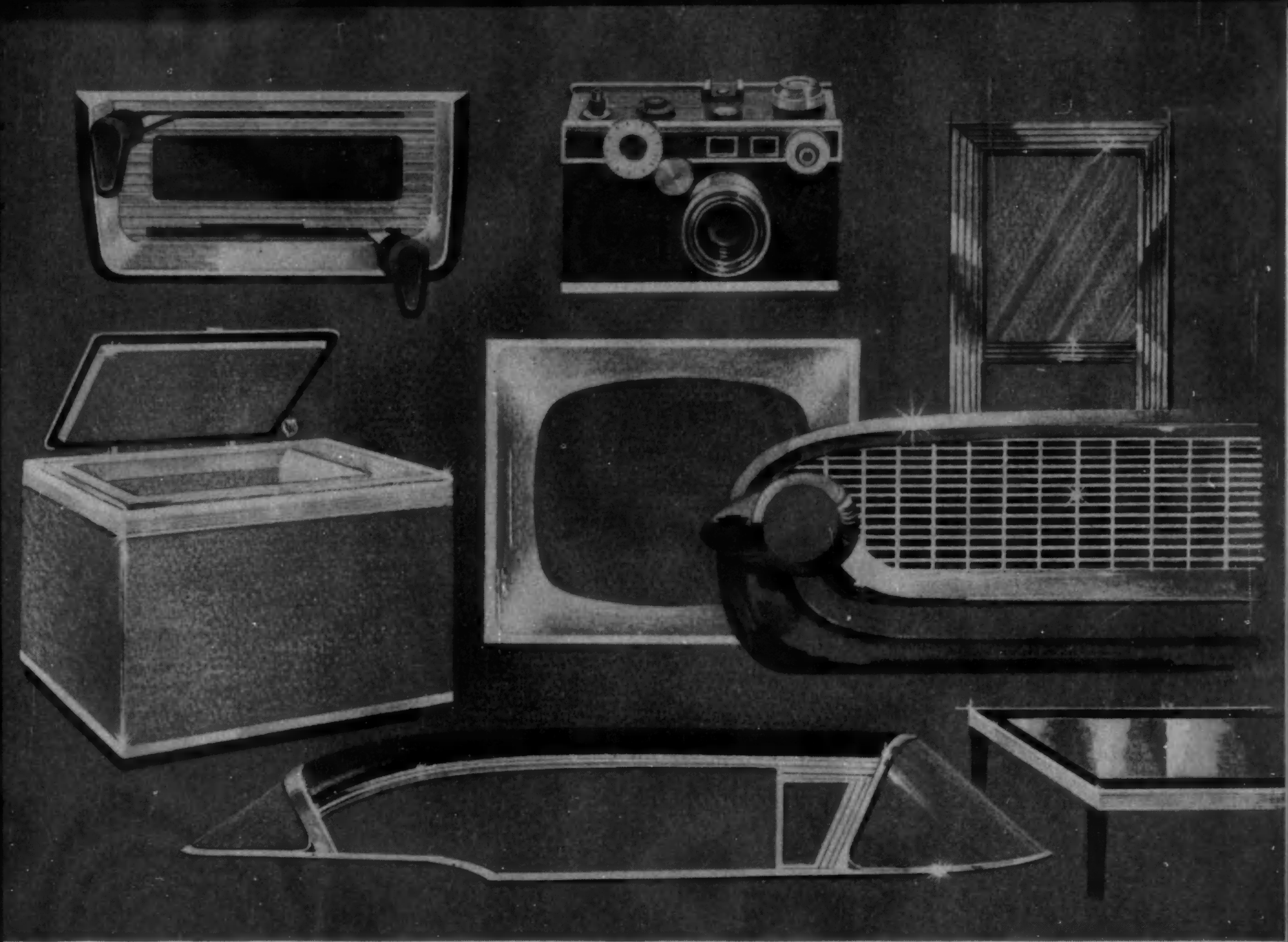

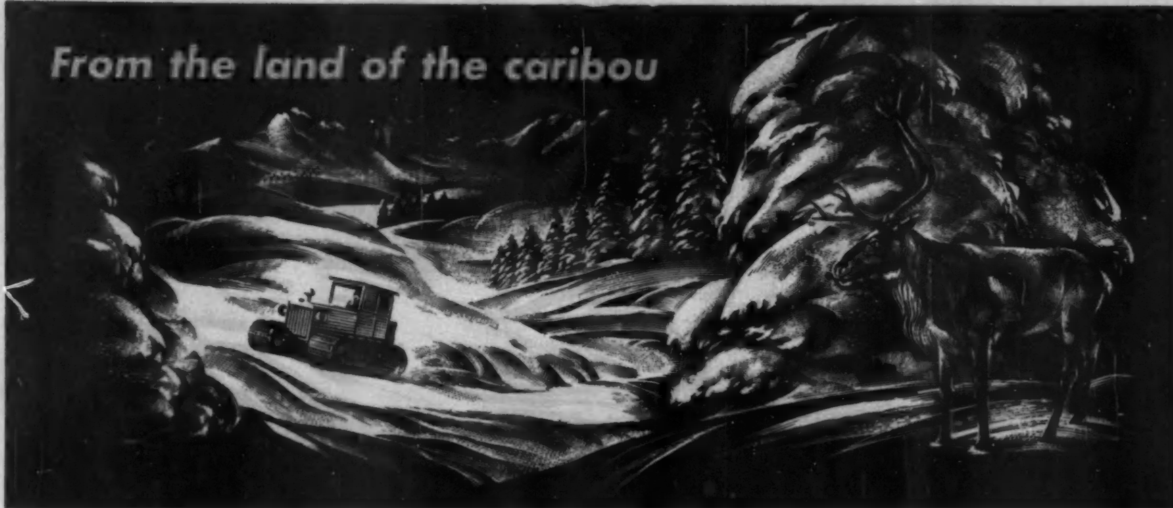

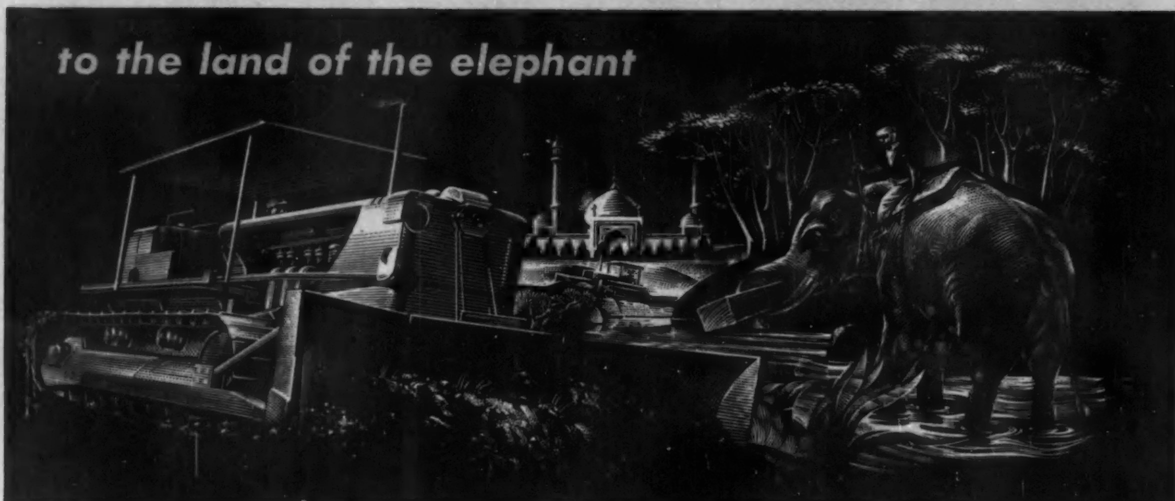

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Other Outstanding Shell Industrial Lubricants

- **Shell Tellus Oils**—for closed hydraulic systems
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- **Shell Dromus Oils**—soluble cutting oils for high-production metal working
- **Shell Macoma Oils**—for extreme pressure industrial gear lubrication
- **Shell Voluta Oils**—for high-speed quenching with maximum stability

Shell Rimula Oil is a heavy-duty oil designed to solve the toughest lubricating problems in diesel engines.

One of these problems—excessive cylinder and ring wear—results from acidic combustion products. It occurs under all operating conditions, but is especially severe under low jacket temperatures. Rimula® Oil contains an alkaline additive that counteracts this acid wear. It remains stable under the widest temperature extremes encountered in modern operation. It keeps engine parts clean and operating efficiently over longer periods . . . effecting worthwhile savings in labor and parts.

Rimula Oil is available to your customers abroad. They can depend upon it for the most severe conditions of diesel operation. For full information, write: Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

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There is no <u>substitute</u> for stainless steel

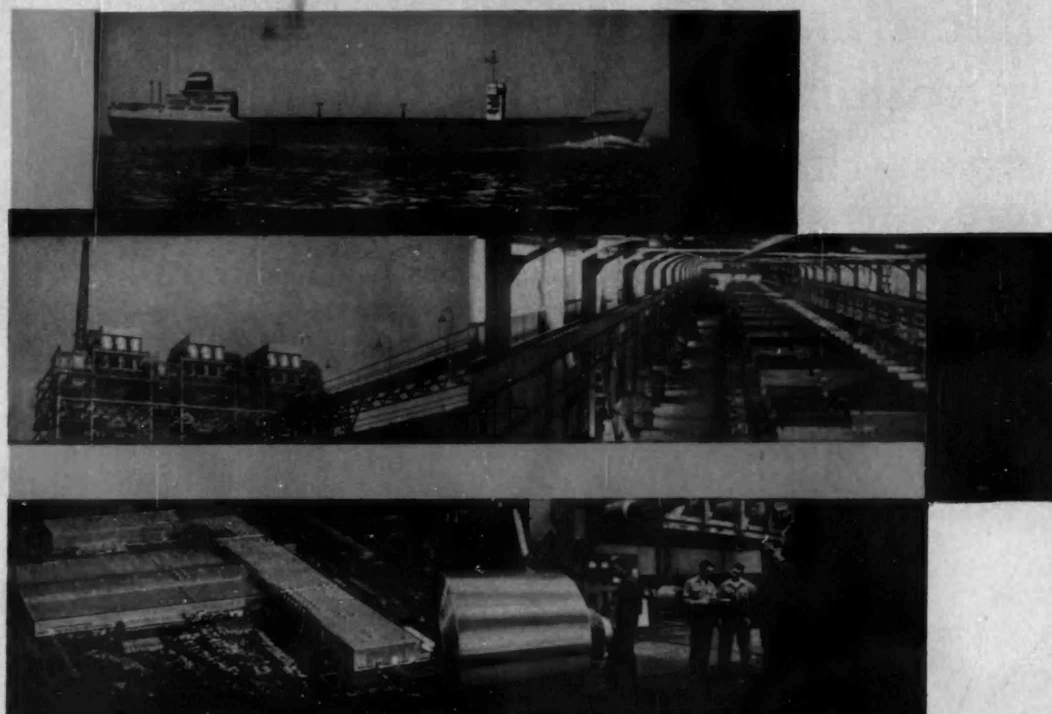
in automobiles

No other material is as bright, strong and resistant to rust and wear as Stainless Steel. It gives every car the clean, exciting beauty that sells in the showroom and re-sells on the used car lot. Look for *Stainless Steel* on your new automobile.

Specify McLouth high quality sheet and strip Stainless Steel. McLouth Steel Corporation, Detroit 17, Michigan.

McLouth Stainless Steel

Full integration makes Olin Aluminum a dependable source for you . . .



Behind every finished order of custom-tailored Olin Aluminum lies a fully-integrated chain of production facilities reaching all the way to the ore fields at Surinam.

Control over every stage of the production of your Olin Aluminum —from ore field to alumina and reduction plants, and to strategically located processing mills—assures you of a dependable source of supply. Now and tomorrow.

Of equal importance, the services of Olin Aluminum Sales Representatives, Field Engineers and Production Engineers, working in cooperation with your own staff, assure you the kind of special customer satisfaction that has been an Olin Mathieson Service principle for years.

For service now, write: Aluminum Division, Olin Mathieson Chemical Corporation, 400 Park Avenue, New York 22, New York.

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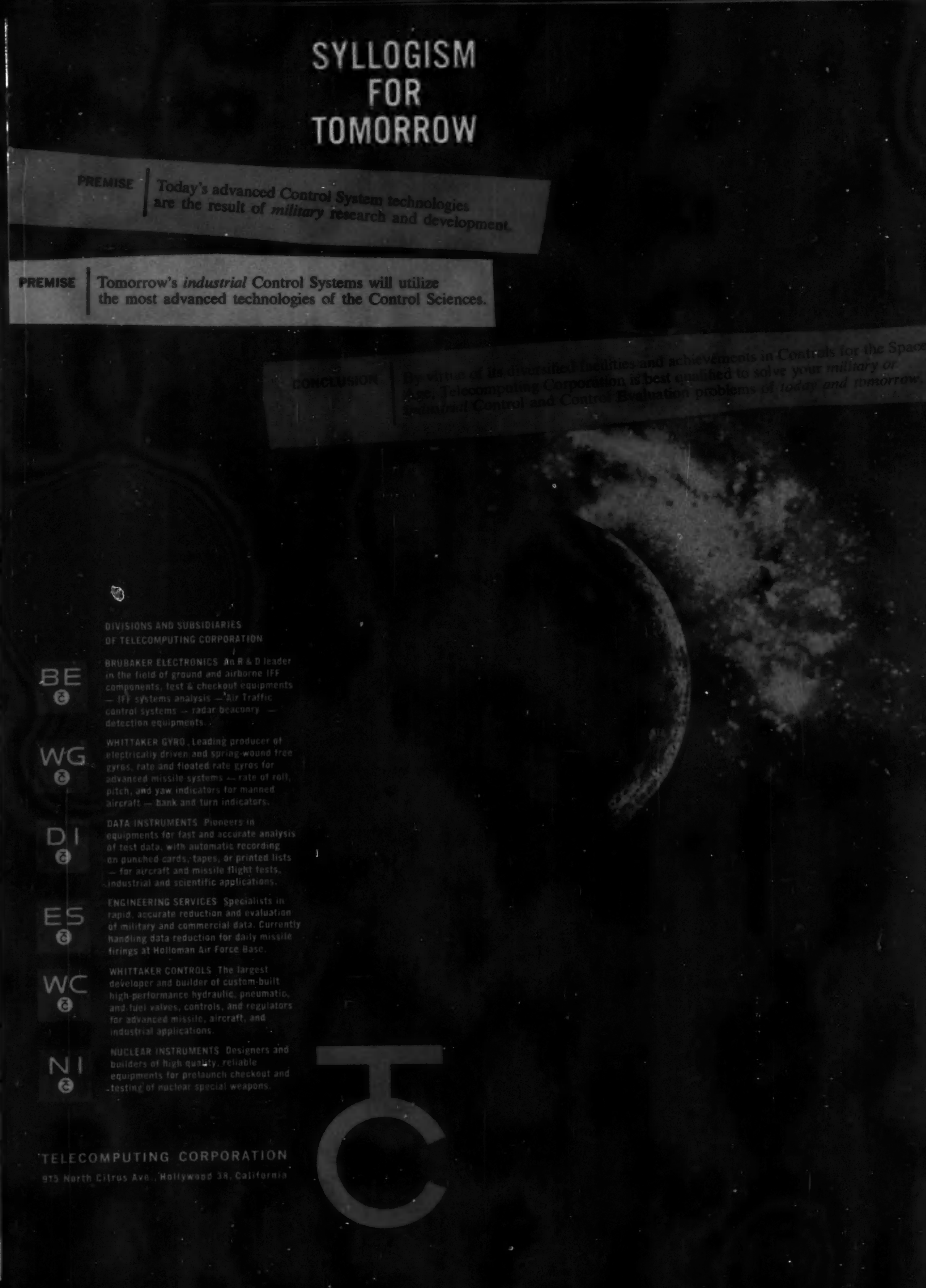
OLIN MATHIESON CHEMICAL CORPORATION

OLIN ALUMINUM

Symbol of New Standards of Quality and Service in the Aluminum Industry



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FOR
TOMORROW
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Today's advanced Control System technologies are the result of *military* research and development.
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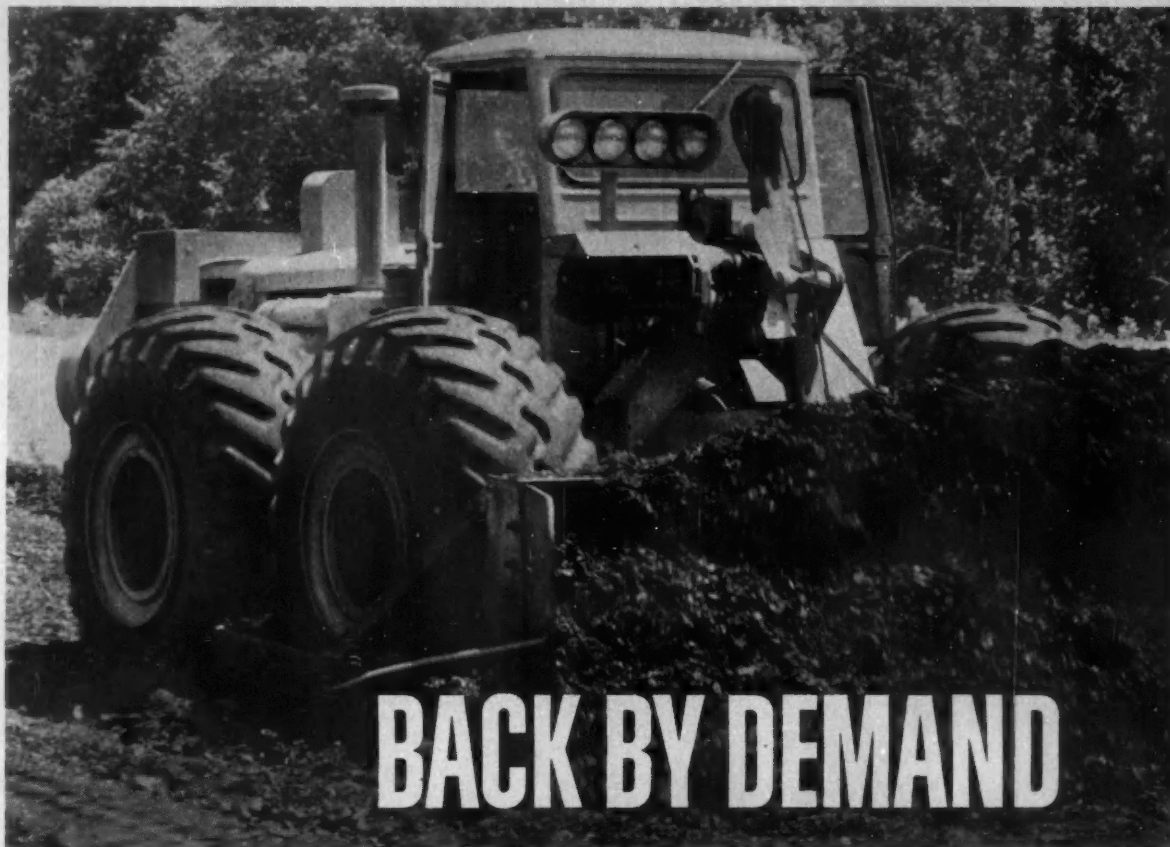


where heavyweights roll!

Firestone Earthmover Rims with Perma-Tite air seal!

Firestone builds new strength into off-the-highway rims! *Fusion-welding* by Firestone's exclusive balanced weld design gives equal penetration inside and out for maximum strength. The new *Perma-Tite air seal* makes rim completely airtight. It's the truest rolling rim you can own—reduces sidewall flexing, results in cooler running tires, cuts downtime. It's stress-tested and specially reinforced at high strain points. For tubed or tubeless off-highway tires.

INTERCHANGEABLE in complete units or by components with all earthmover rims and parts.

SPECIAL PROTECTION against rust and corrosion for longer rim life, stronger tire performance.

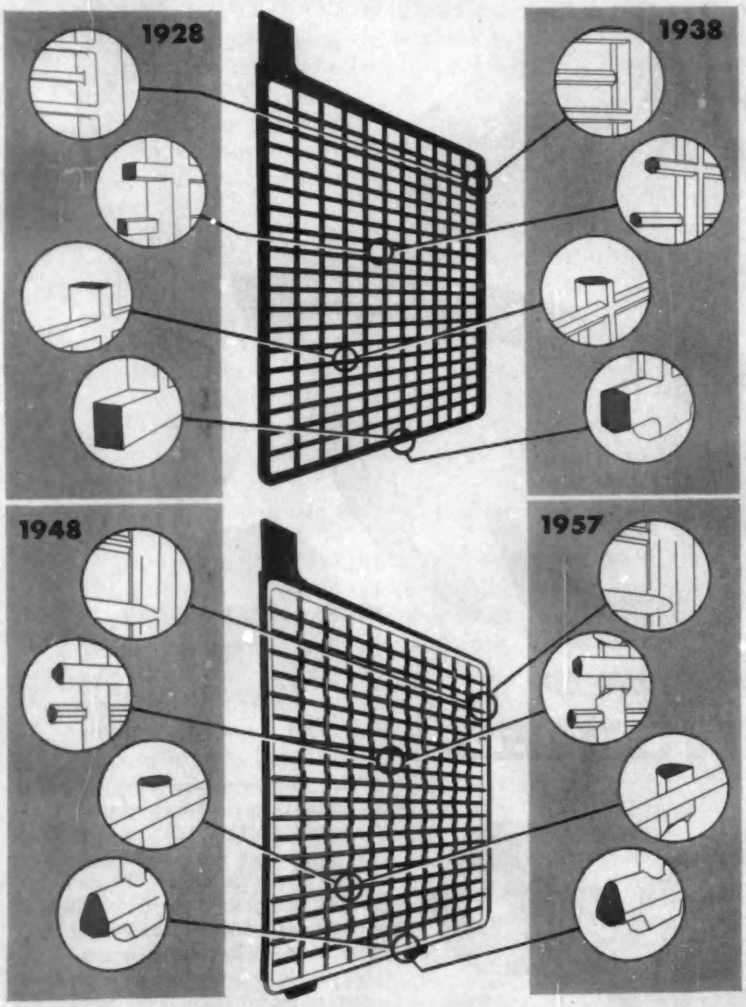
PERMA-TITE AIR SEAL . . . the greater the pressure, the tighter the seal.

FIRESTONE STEEL PRODUCTS CO.
AKRON, OHIO

to GLOBE RESEARCH no battery is ever perfect

from Globe Research

Significant design changes in grid cross sections 1928 through 1957



. . . grids that are designed for:

- **High strength**
- **Corrosion resistance**
- **Good conductivity**
- **Greater oxide retention**

Charts at the left illustrate progressive changes in grid design resulting from Globe's 30-year advance toward battery perfection through research and development. These changes are small physically, but very significant in bringing buyers the efficient, low-cost, peak-performance battery of today . . . the Globe Spinning Power Battery . . . unsurpassed in quality for either original equipment or replacement.

For more information on grid design write for Bulletin G57.

Globe Spinning Power Batteries are now available for fast, low-cost shipment from 16 strategically located plants — 15 (*) now producing dry-charged batteries:

*ATLANTA, GA., *DALLAS, TEXAS, *EMPORIA, KANSAS, *HOUSTON, TEXAS, *LOUISVILLE, KY., *MEDFORD, MASS., *MEMPHIS, TENN., *MILWAUKEE, WIS., *MINERAL RIDGE, OHIO, *PHILADELPHIA, PA., *REIDSVILLE, NO. CAROLINA, *SAN JOSE, CALIF., *HASTINGS-ON-HUDSON, NEW YORK, *LOS ANGELES, CALIF., OREGON CITY, OREGON, *TAMPA, FLORIDA.

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GLOBE-UNION
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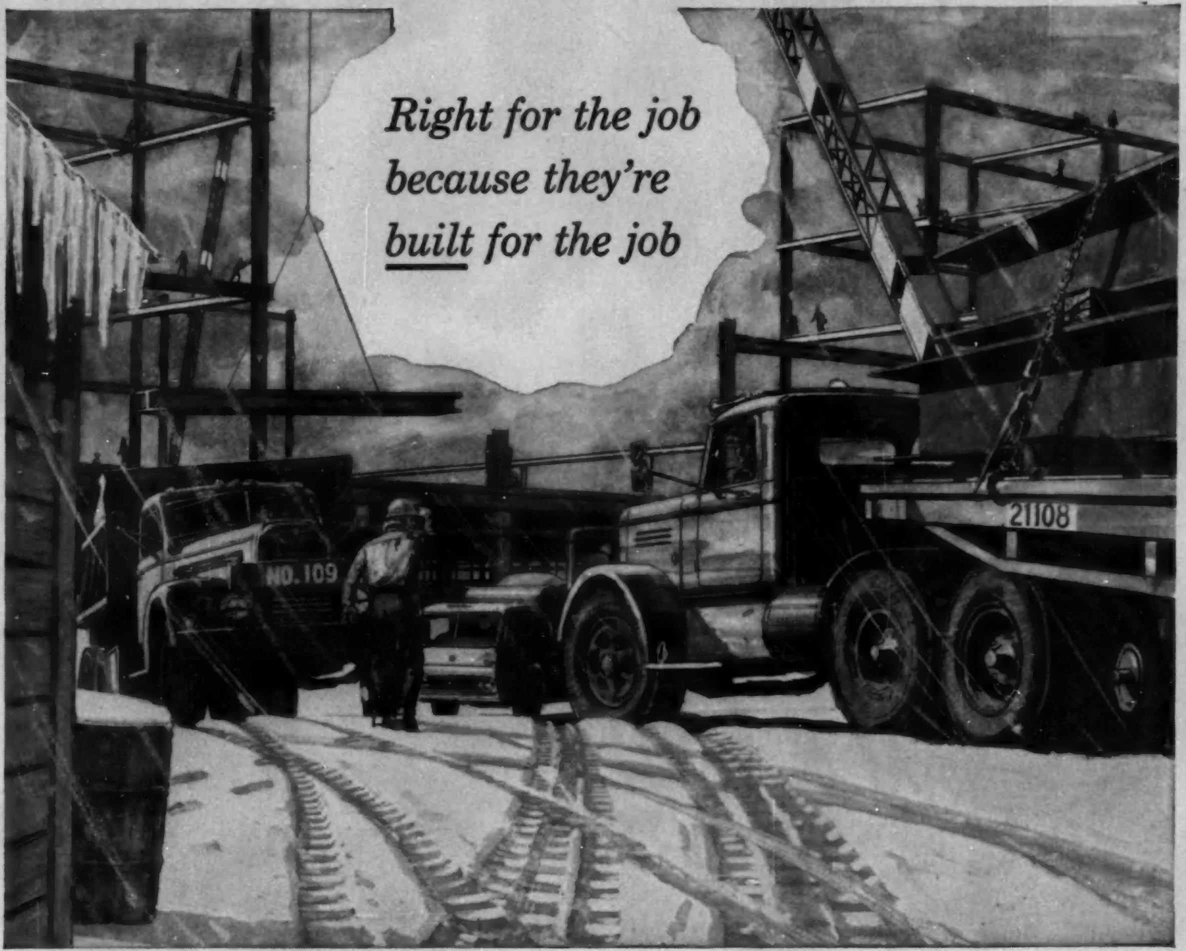
GLOBE-UNION INC.

MILWAUKEE 1, WISCONSIN

If it's Petroleum-powered there's a GLOBE-BUILT BATTERY right from the start!



EVANS HEATERS ARE RIGHT FOR TRUCKS BECAUSE THEY'RE BUILT FOR TRUCKS

It goes without saying that your truck has to be *truck built* all the way through. Including the heater!

You'll find *every* Evans heater is *truck built*. Each is designed to meet the specific heat and installation requirements of the type truck it is to serve. This means both correct BTU output *and* proper heat distribution . . . something a warmed-over car heater cannot provide.

It also means longer heater life. To prove it, Evans backs every heater with a parts "repair or replace" warranty good for a full year or 50,000 miles, whichever occurs first.

EVANS PRODUCTS COMPANY

PLYMOUTH, MICHIGAN

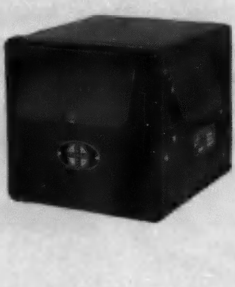
An Evans heating engineer will be happy to work with you in solving *your* truck heating problems. Write for complete information: Evans Products Company, Dept. Z-6, Plymouth, Michigan.

Regional Representatives: Cleveland, Frank A. Chase
Chicago, R. A. Lennox Co., Inc.; Detroit, Chas. F. Murray Sales Co.
Allentown, Pa., P. R. Weidner

EVANS PRODUCTS COMPANY ALSO PRODUCES:

railroad loading equipment; bicycles and velocipedes; Evaneer® fir plywood; fir lumber; Evanite® battery separators; Evanite® hardboard; Haskelite doors; Evanite Plywall.

EVANS ®



AIR BRAKE PARTS . . . . .

Which method

The parts buyer with the furrowed brow has reason to be worried. Better than anyone he knows that an automotive air brake system is no stronger than its weakest link, that failure of a single device can cause unnecessary downtime expense and may even risk lives and valuable property. A trivial saving, he well knows, can become a costly extravagance!

By way of contrast, the buyer at right reflects "systems serenity". He is systems conscious, and when he buys air brakes he buys genuine Bendix-Westinghouse Air Brake systems. He knows that Bendix-Westinghouse Air Brake equipment is "system engineered"—that each unit is designed to perform a specific operation in a closely related

. . AI

of

systen
forma
device
compo
A pi
motive
Westi

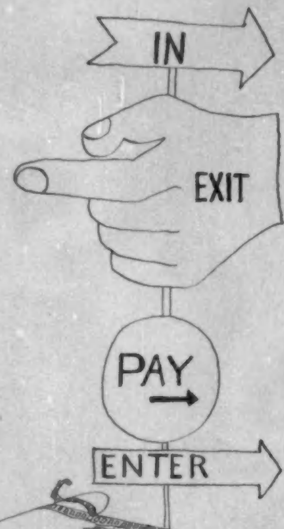
Signs of our times

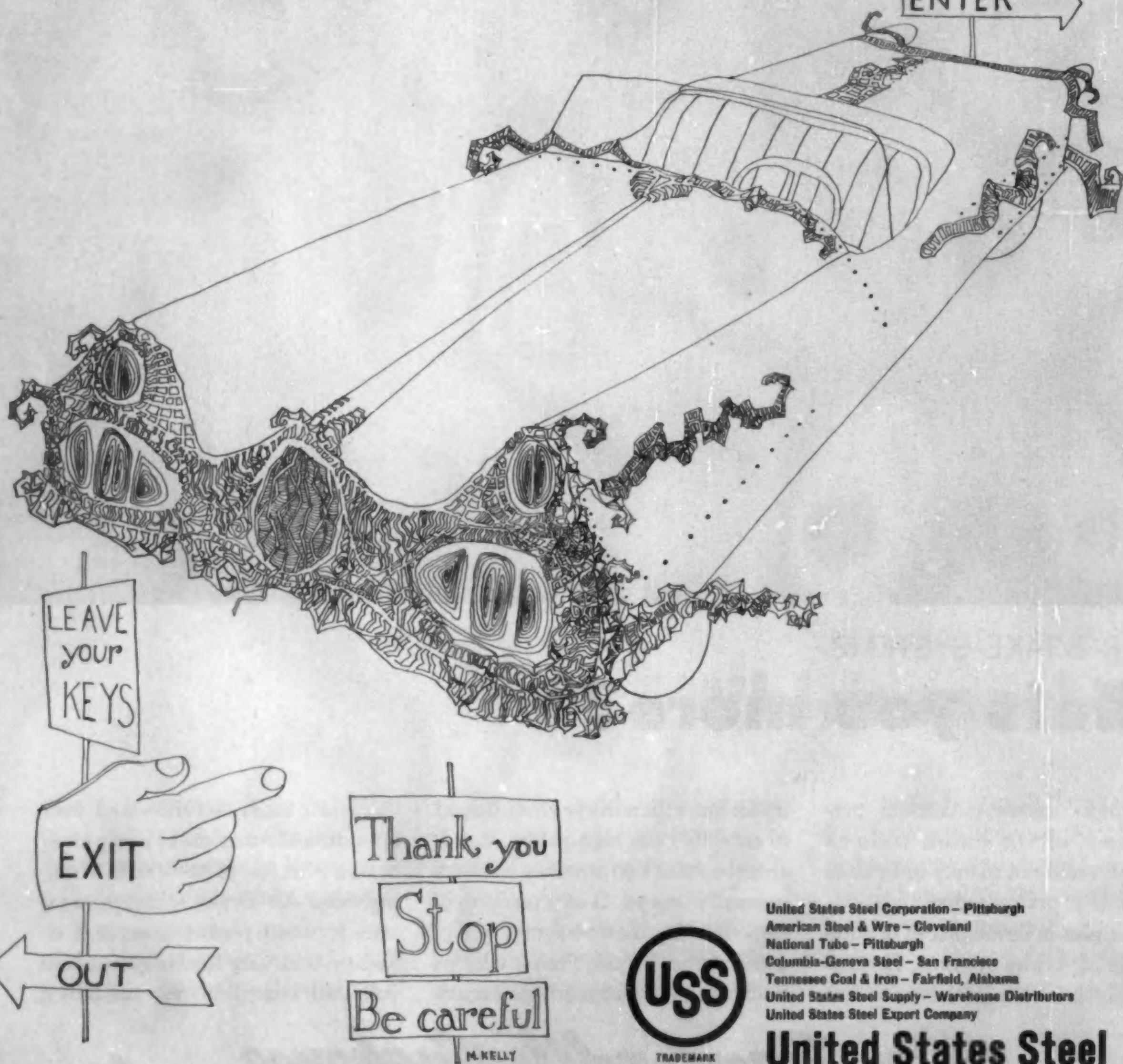
As he tools along the broad highway, many a motorist purrs with delight as he contemplates the leaping horsepower beneath his hood. But when he hits town, he is instantly intimidated by a snarl of roaring trailer trucks, camouflaged stop lights and nerve-shattering policemen.

Thoroughly beaten, he slinks into a parking lot, goggle-eyed at a sea of authoritative signs and is greeted by a lineup of car jockeys who wait for a chance to spin his tires on the black cinders and crinkle the shining trim that adorns the car.

Spare the motorist that last injustice. Use Stainless Steel trim whenever possible. It's so hard and strong that only the most determined parking lot attendant can dent it or knock it loose. As for corrosion resistance, no other metal will stay so bright and handsome for so long.

Designers have also learned that Stainless Steel is often the least expensive form of trim because there is no need to allow for corrosion, and you eliminate a lot of production steps. Want more information? Write United States Steel, Pittsburgh, Pa., or our American Steel & Wire Division, Cleveland, Ohio.





USS
TRADEMARK

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American Steel & Wire – Cleveland
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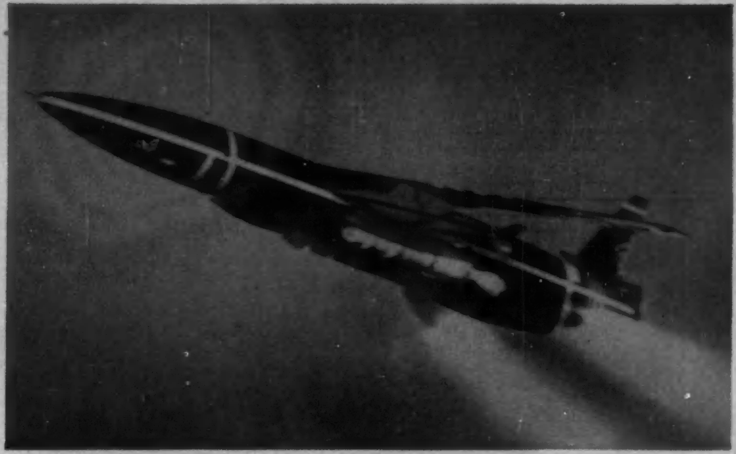
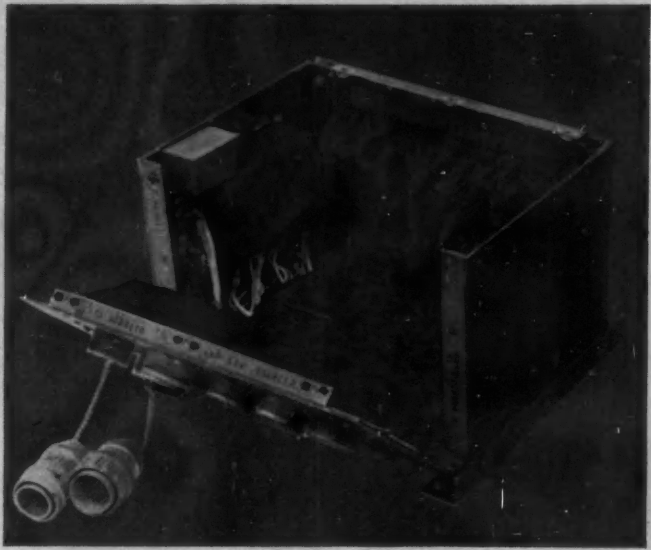
The MISSILE:



U. S. A. F. Northrop's SM-62 Snark, with a range of more than 6000 miles. Now operational, the Snark is America's first intercontinental guided missile. Powerplant is a Pratt & Whitney J-57 turbojet. Guidance is by a stellar-monitored inertial system.

The MATERIAL:

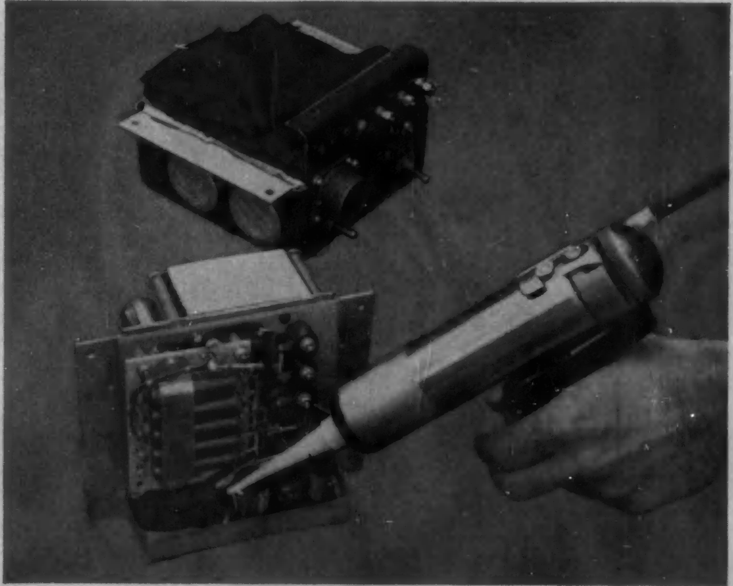
SILASTIC



In the Snark, panels containing resistors, capacitors, transistors and other electronic components are cushioned by Silastic*, the Dow Corning silicone rubber. Silastic protects against moisture, vibration damage, electrical leakage.

*T.M.REG.U.S.PAT.OFF.

The METHOD:



Encapsulating with Silastic RTV, via calking gun. Silastic RTV vulcanizes completely at room temperature. When vulcanized, it has the characteristics typical of Silastic: resistance to extreme temperatures, moisture, ozone, corona. Electrical properties are excellent. Silastic RTV can be slit open for repair work and then re-sealed. Write for sample and technical data.

Address Dept. 916

first in silicones

Dow Corning
CORPORATION
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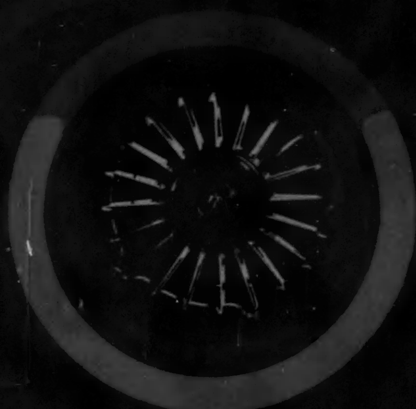
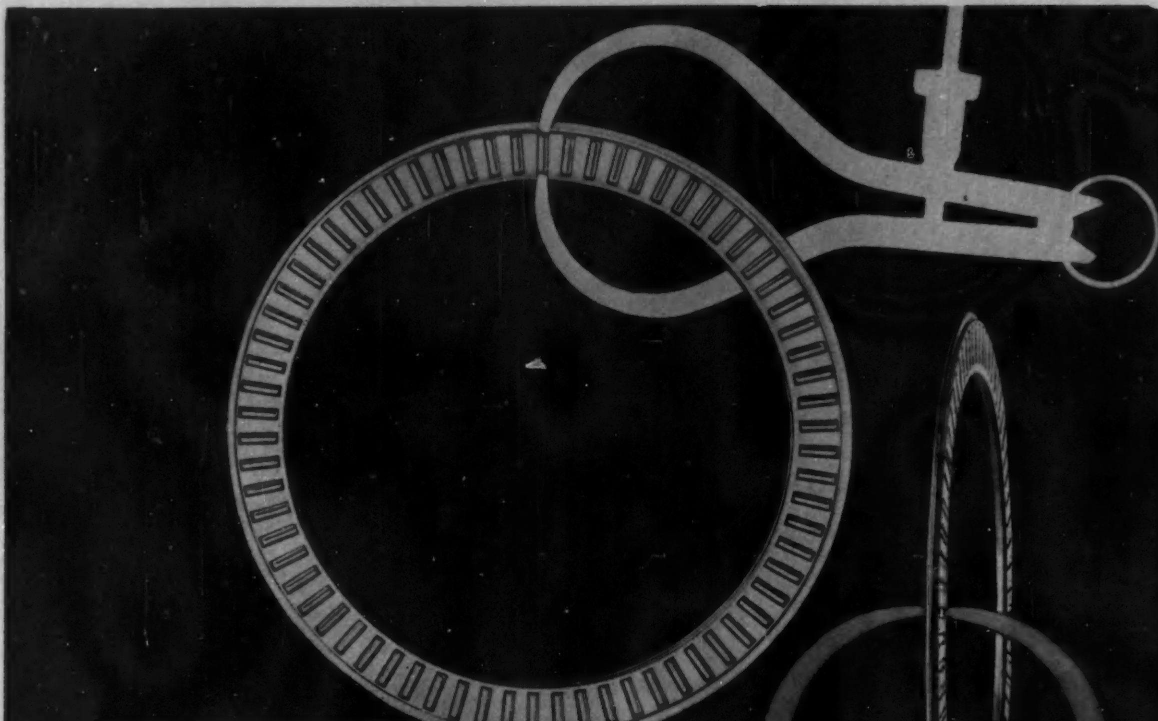
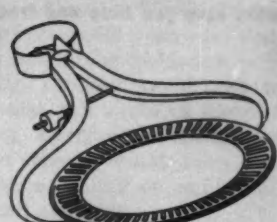


on the highways tomorrow...

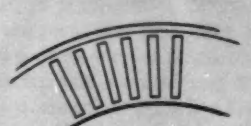
with integral wheel,
brake drum, hub
and wheel cover



It's .0781" THIN! . . . to meet the most restricted space needs.



OD is much smaller, for given shaft size, than other types of thrust bearings.



Needle-proportioned rollers provide large contact area in minimum cross section.

By Every Measure . . . Ideal For Compact Thrust Applications

Whether you gauge its value in compactness, high anti-friction efficiency, high thrust capacity, or low unit cost, you will find the new Torrington Needle Thrust Bearing measures up ideally to your needs.

This needle-type bearing is designed specifically for thrust loads in restricted space. It may run directly on adjacent hardened and ground surfaces or on standard thrust races. Used alone, or in combination with Torrington radial type Needle Bearings, the Needle Thrust Bearing finds wide use in many applications including steering gears, hydraulic pumps, tractor bolsters, bevel and worm gear boxes, governors, outboard motors, 2-cycle engines, washing machines, power tools, torque converters, and automatic transmissions.

For engineering information and assistance in design, please call upon the services of Torrington's Engineering Department. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

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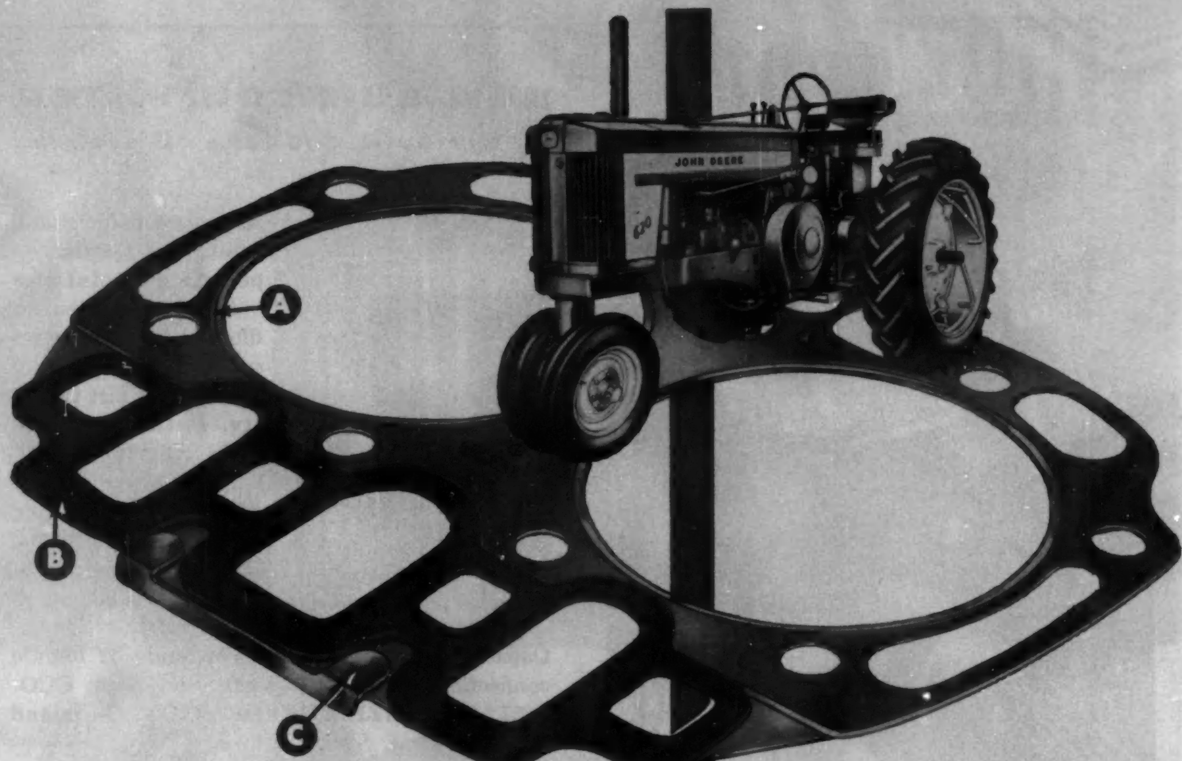

How JOHN DEERE seals an intricate block casting

JOHN DEERE engineers assume no limitations on what can be done with gaskets. For example, take the case of sealing the Model 620 tractor engine.

Intricate block design created the problem of effectively sealing the coolant ports beyond the area of stud loading. The seal would have to compensate for heat expansion and shifts of the water holes in the block casting. Compressed thickness and resilience of the gasket overall would have to be balanced to insure maximum sealing of combustion chambers, exhaust, fuel and air ports.

Solution Comes from Standard Design

How JOHN DEERE engineers in cooperation with Victor specialists solved this problem is shown here. This partial modification of the standard VIC-2-FOLD design suggests the flexibility and wide scope of economical sealing service available from Victor.

Whatever you have to seal with gaskets or oil seals, Victor's unmatched facilities are yours to use. Contact your Victor Field Engineer or the factory.

Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill.—Canadian Plant: St. Thomas, Ont.

A → **VIC-2-FOLD** modern metal-asbestos design insures tight sealing of combustion chambers, exhaust, fuel and air ports. Steel bottom layer, turned up and overlapping copper top layer at combustion openings, gives strong protection against breakdown and blowout. Copper top, turned down and overlapping steel layer, protects against corrosion.

B → **VICTOPRENE** insert, bonded to steel bottom layer, with overlap on openings, provides tight sealing of coolant chambers. Victoprene was selected for its lowest compression set values.

C → Shim stop of brass, riveted to bottom steel layer, prevents excessive compression on Victoprene insert.

Your files are not complete without Victor Gasket Engineering Catalog No. 505.

VICTOR®

Sealing Products Exclusively

GASKETS • PACKINGS • OIL SEALS • MECHANICAL SEALS

Albee Rolligon covers world's roughest

Six individually powered, high-traction pneumatic rollers carry the Albee Rolligon most anywhere, imposing a ground load of only 5 psi at 21,000 lbs. G.V.W. Designed and built for dependable, off-the-road operation by Albee Rolligon Co. of Monterey, Calif., the ARC uses 54 feet of leakproof Bundyweld for vital fuel and hydraulic lines. And its powerful V-8 engine uses additional lengths of dependable Bundyweld for fuel and oil lines.

BUNDYWELD IS DOUBLE-WALLED FROM A SINGLE STRIP

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

← NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

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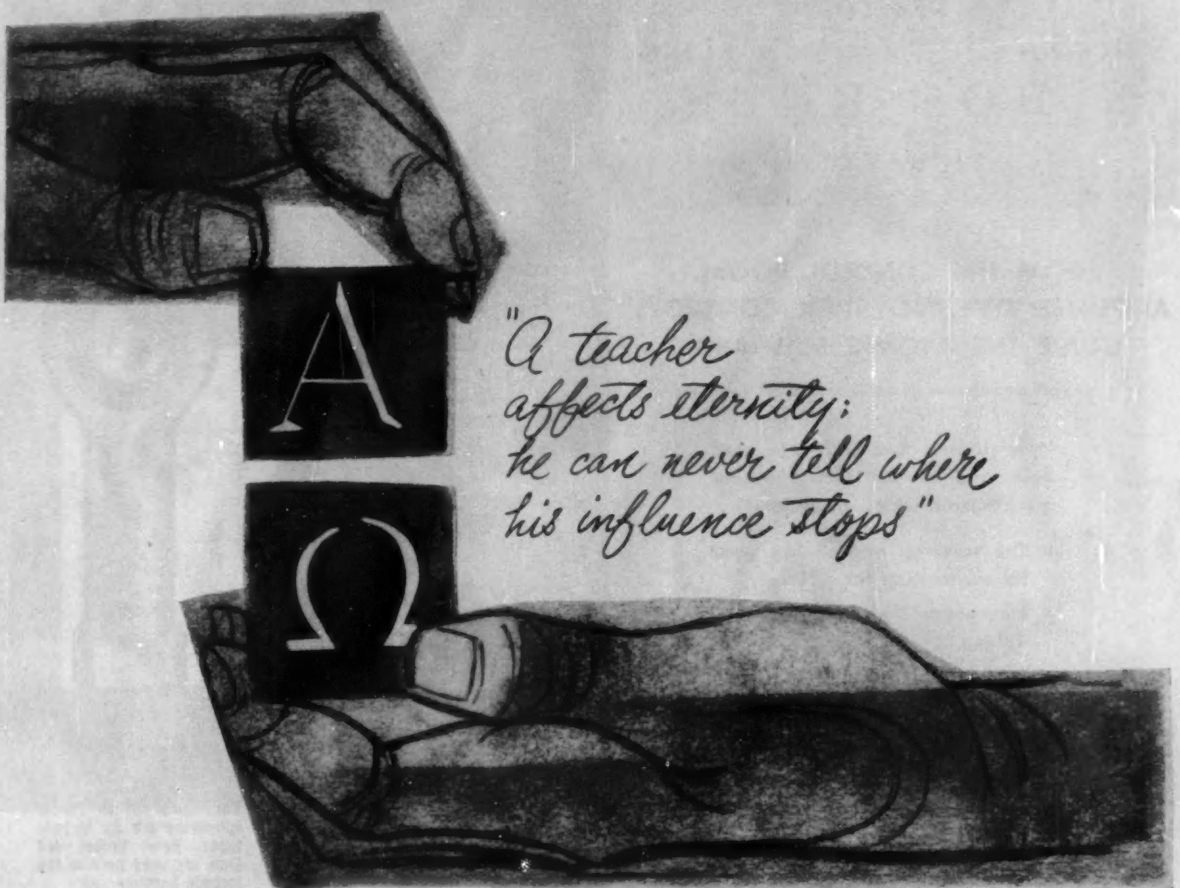
American Pioneers of Progress



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CARTER CARBURETOR

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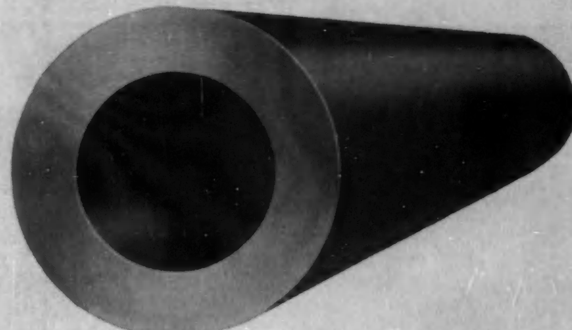
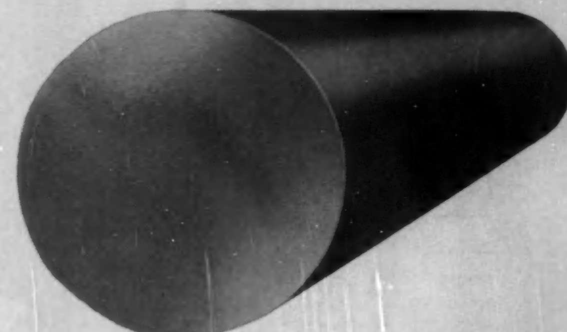
Start with a hole . . .



instead of a headache



Start with TIMKEN® seamless tubing and save steel, machining time

BORING out bar stock to make hollow parts is a waste of steel and valuable machining time. Besides, it's a headache. The remedy is Timken® seamless steel tubing with *the hole already there.* You pay only for the steel you use. On top of this saving, you cut machining costs. By eliminating that unnecessary boring operation you free part of your screw machines for other jobs—add machining capacity without adding machines.

And you can actually get a better quality finished product with Timken seamless steel tubing. The reason is the way we make it. A solid round is forged over a mandrel, thoroughly working the metal inside and out. It's this rotary piercing operation that gives Timken seamless steel tubing its fine forged quality and uniform spiral grain flow for extra strength. Carefully controlled temperature and piercing speed keep this quality uniform from tube to tube, heat to heat, bar to bar.

We can help you increase your steel savings by having our engineers recommend the most economical tube size for your hollow parts job. They'll give you a size guaranteed to clean up to your finished dimensions. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U. S. PAT. OFF.

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